In This Issue *A Noteworthy Symposium on Electric Rates, and Electric Cooking and Water Heating, by a Number of Prominent Men of the Electrical Industry throughout the West*

JOURNAL OF ELECTRICITY

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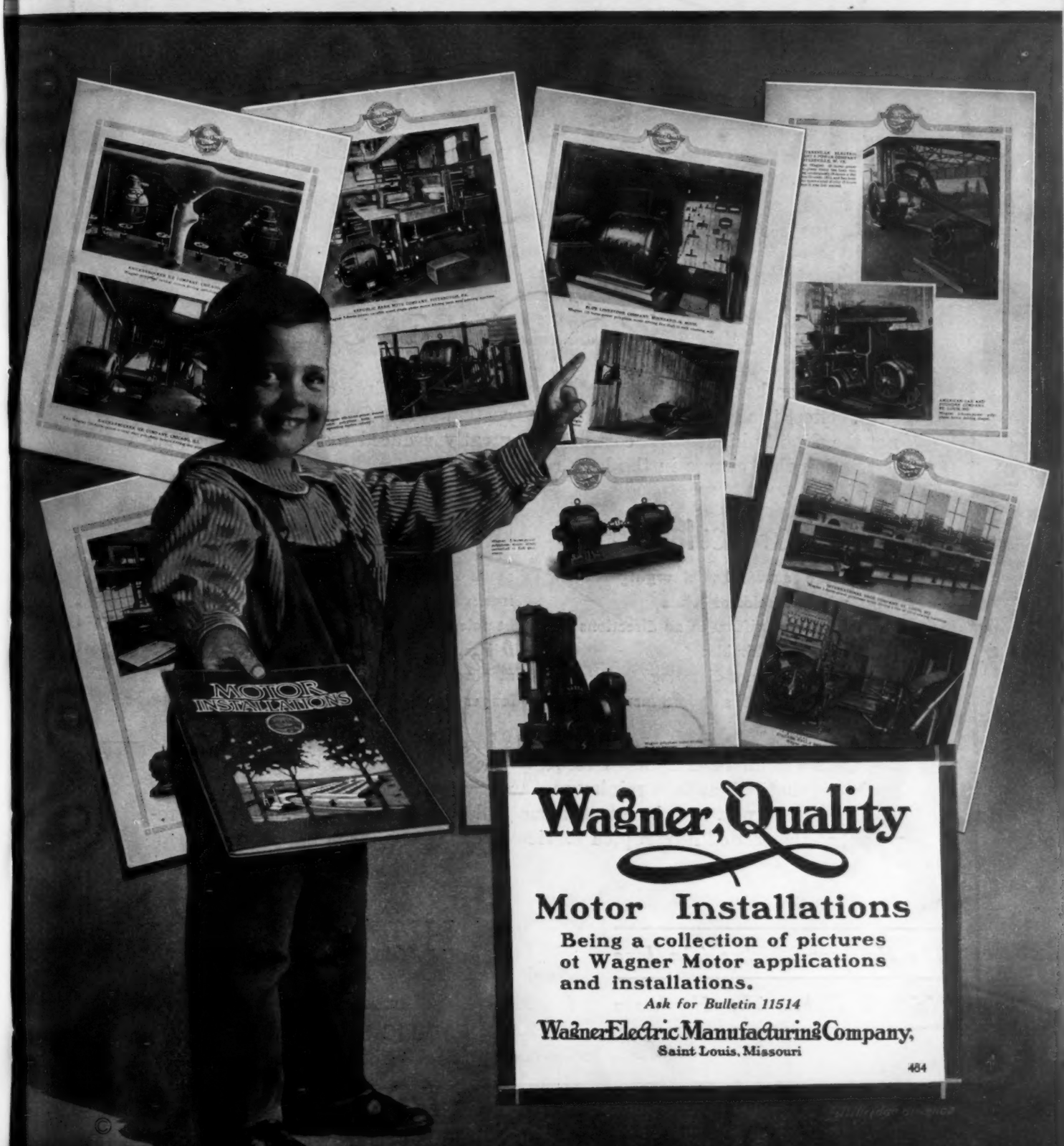

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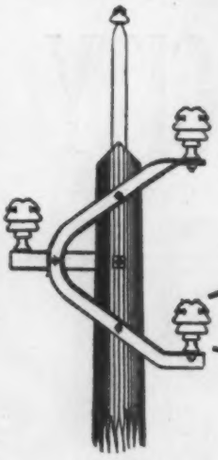

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Devoted to the Generation, Distribution and Utilization of Energy

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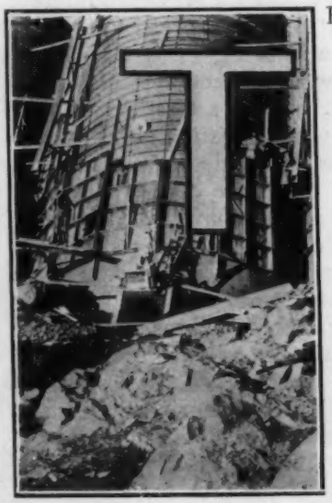
The Multiple Arch from the Rear, showing its Non-Leakable Nature When Under Water Pressure

ROCK CREEK MULTIPLE ARCH DAM

BY R. A. MONROE

(Multiple arch dams under certain definite conditions are finding broad application throughout the West. Here is a new advance in such design in that knuckle joints are made at the juncture of each arch with its support. This provision makes possible a certain elasticity and freedom from strain not otherwise experienced in multiple arch installation. This article as a consequence should receive wide attention from engineers throughout the West. The design in question is that of the new Rock Creek Dam for the Wise power plant of the Pacific Gas & Electric Company. The author is the engineer who had charge of the detail design under the general direction of the civil and hydraulic engineer of the company.—The Editor.)



A Multiple Arch Unit Under Construction

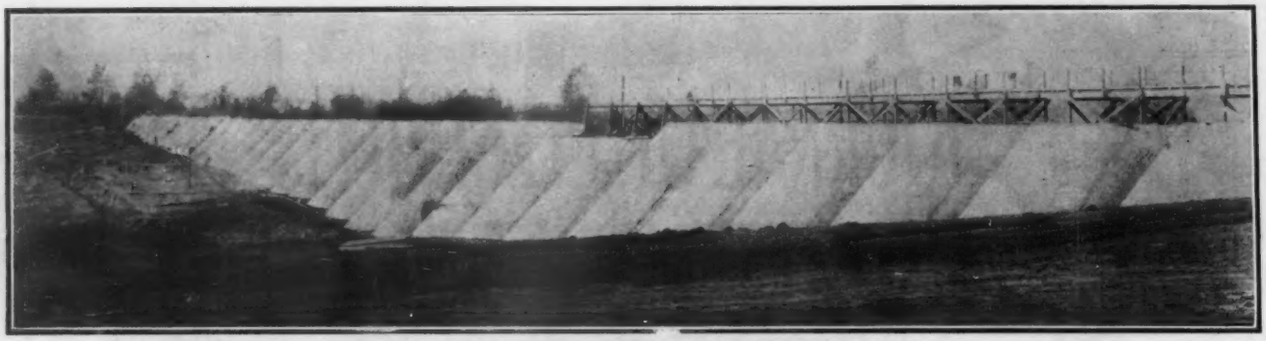
THE Pacific Gas & Electric Company has recently completed the James H. Wise hydroelectric development in Placer County, California. The installation at the Wise Power House consists of a 20,000 h.p. turbine, and uses the water from Spaulding dam after it has passed through the Halsey and Drum power houses which are located higher up in the mountains.

One of the most interesting features in connection with this development is the Rock Creek Multiple Arch Dam, which is located about four miles north of Auburn. It is built across the channel of Rock Creek and creates a reservoir which serves to regulate the flow in the canal between the Halsey and Wise power houses, and also to provide additional storage to take care of the peak load requirements of the Wise Power House.

The dam as at present constructed consists of two sections. The main channel is spanned by a multiple arch concrete dam of 1050 ft. in length, which at one end is joined to an earth fill dam of 825 ft., the crest length making an angle of 30° with the center line of the multiple arch dam. It impounds a net storage of 440 acre ft., and is designed to permit of raising 17 ft. in height which will increase the reservoir capacity to 2500 acre feet. When this extension is made, it is intended to replace the earth wing dam with a multiple arch concrete dam.

The earth dam contains 11,690 cu. yds. of material and has a maximum height of 15 ft. The crest width is 10 ft. with a slope of 2½ to 1 on the upstream face and 2 to 1 on the downstream face. The outlet structure for the canal is located in this dam and the flow is controlled by two 4 ft. by 6 ft. motor operated gates.

The multiple arch dam consists of 35 arches of 30 ft. span each, giving a crest length of 1050 ft. The maximum height of arch when the dam is completed will be 53 ft. above the foundation level, but at present the maximum height is 17 ft. less than this.



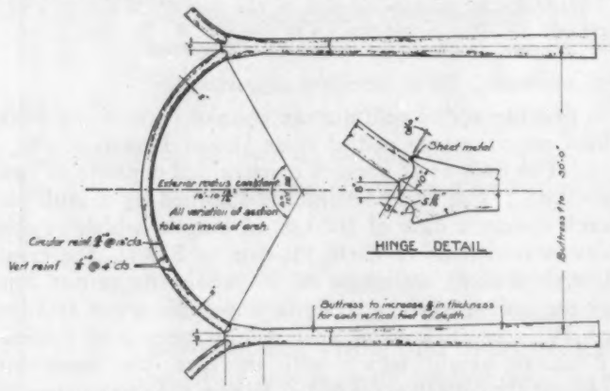
Front View of Rock Creek Dam

The buttresses are 4 ft. long by 12 inches thick in plan on top and increase in thickness two inches for each five feet in depth. On the downstream face the buttresses have a batter of one in twenty and in the plane of this face at 17 ft. intervals horizontal reinforced concrete beams are used to brace them.

The arch rings are circular in the plane of the water thrust and the axis is inclined at an angle of 45°. The radius of the extrados or upstream face is constant, being 16 ft. 10 13/16 in. All variation of section are on the intrados, and between hinges the arch ring subtends an angle of 120° 28′. The thickness of the arch ring normal to the water thrust at the crest is 12 in. and increases one inch for each ten feet of vertical depth.

In the design of the arch ring the following factors were taken into account in the stress calculations, which were made for a section of ring normal to the inclined axis: Temperature range, dam full 35°; temperature range, dam empty 45°; coefficient of shrinkage of concrete .0003; and rib shortening due to dead and live load.

The variable dead load due to the arch ring having a constant thickness in a horizontal plane while the



The Hinge Detail for the Multiple Arch

section considered is taken in a plane inclined at 45°.

In order to check the assumed temperature range, thermometers have been installed in the concrete of the dam and the results so far are such as to justify the assumptions made in the design.

In order to reduce the excessive bending stresses which are caused by the above loadings in a hingeless arch, the structure is designed as two hinged. The hinges are formed of concrete, and located at the point where the arch ring joins the buttress as shown in the accompanying plan. As the radius of the ball and socket joint was kept small in order to avoid excess frictional resistance to turning, the curve of the hinge did not reach through the arch rib. In order therefore to allow for movement of the joint, it was necessary to fasten a U-shaped strip of sheet metal to the downstream face of the buttress hinge. This served to keep the concrete of the arch from butting up against the buttress, thus permitting the hinge to rotate. Rotation in one direction only was to be expected so this provision was only made for one face. In constructing the dam, the buttress hinge face was carefully smoothed down and painted with graphite paint before the arch ring was poured up against it.

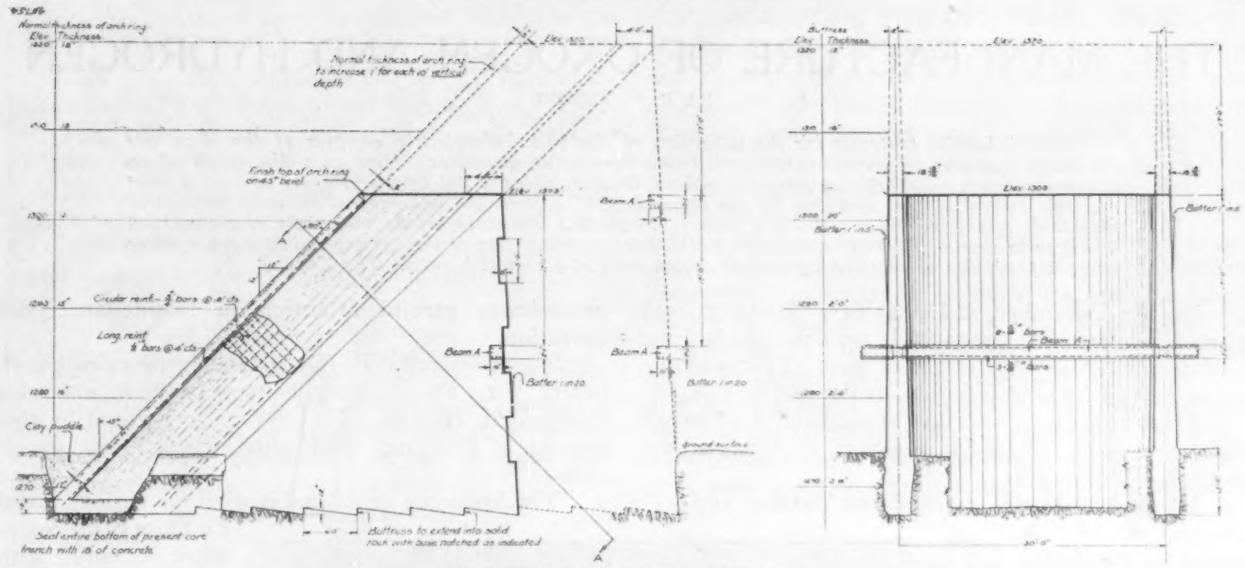
The buttresses are not reinforced nor is the extrados of the arch. The intrados of the arch is reinforced longitudinally by ½ inch square bars at 4 ft. centers and in the plane of the circular ring by ¾ inch square bars at 18 inch centers.

A spillway is provided near the center of the dam to care for a maximum flow of 925 sec. ft. The spillway crest is dropped 3 ft. below the crest of the main dam for a width of two of the arches and a slab is carried down the back of the buttresses supported by beams extending between them.

The foundations are in general carried down to solid rock which varies from 1 ft. to 8 ft. in depth below the ground surface. In two cases after going down over twenty feet no solid rock was encountered, so the footing for these buttresses is spread to ten feet in width and designed as a slab.

For the construction work the concrete plant was located at one end of the dam and a trestle was built the full length of the dam to an elevation of 8 ft. above the crest. This trestle was 8 ft. wide and a track was laid over which steel side dump ore cars of 20 cu. ft. capacity were pushed by hand to convey the concrete. From the top of the trestle the concrete was spouted into place. The buttresses for the entire dam were poured first, each buttress being completed in one pour. The arches were poured in three sections of about twelve arches each; the concrete being deposited along the entire length of the section. Two shifts of eight hours each were employed in pouring the arches.

Forms for the buttresses were built up in place, except those for the hinge joint which were sectional. The forms for the intrados of the arch were built up, using two layers of ½ inch thick O. P. sheathing bent horizontally over studs spaced at two foot centers which were held in place by built up circular rings two inches thick, inclined at 45°, and spaced at 8 ft. centers. The forms for the extrados of the arches were


Normal thickness of arch ring
Normal thickness of arch ring to increase 1' for each 10' vertical depth
Finish top of arch ring on 45° bevel
Beam A
Batter 1 in 20
Circular reinf. - ¾ bars @ 6" ctrs
Long reinf. ¾ bars @ 6" ctrs
Clay puddle
Ground surface
Seal entire bottom of present core trench with 1:6 of concrete
Buttress to extend into solid rock with base notched as indicated
Elev. 1300
Batter 1 in 10
6-¾" bars
3-¾" bars

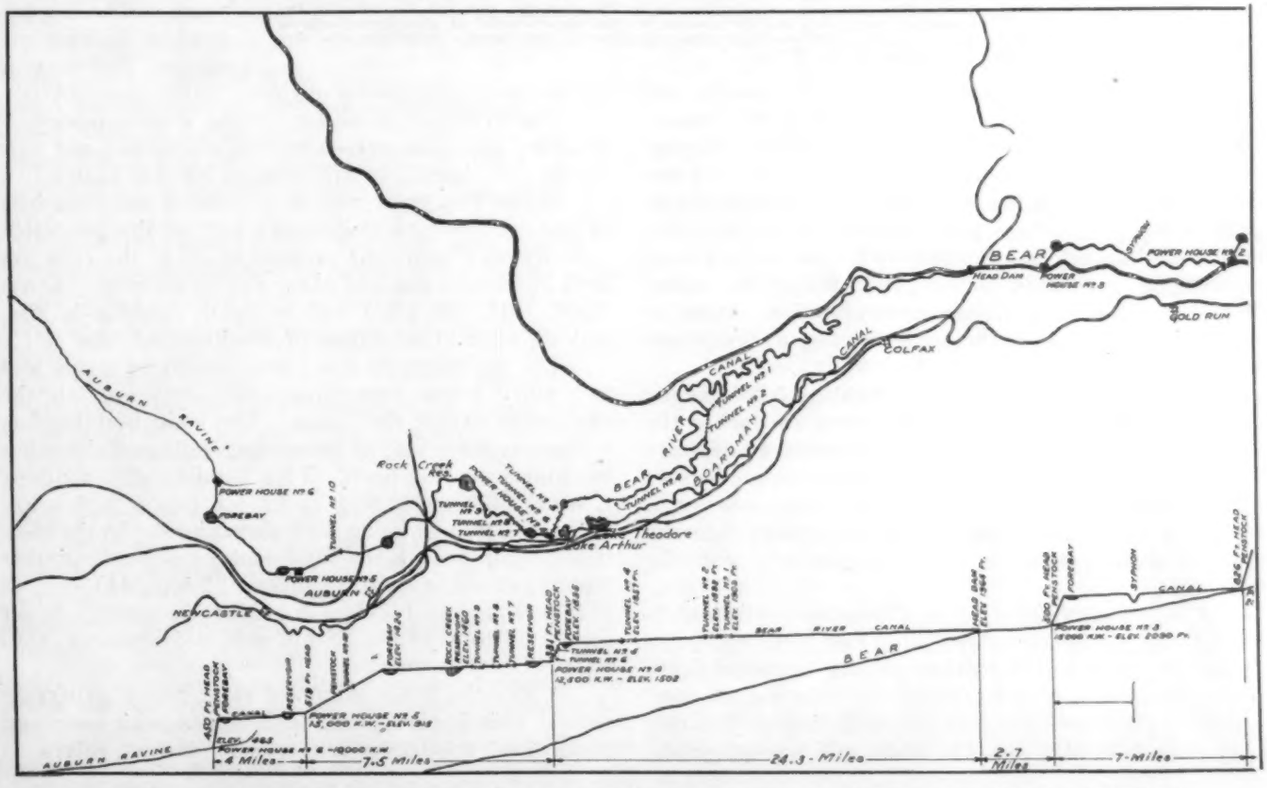
Side and Rear Elevation of Buttress

sectional, each section being 3 ft. wide by 6 ft. long. It was found that four rows or layers of the exterior sectional arch forms were necessary for the length of the section being poured in order to allow the work of pouring and stripping to proceed simultaneously.

The concrete mix for the buttresses was 1-2-½-5, and that for the arch rings was one part cement, one an one-half parts sand, two and one-sixth parts rock of size dust to ¾ in. and 2 1/6 parts rock of size ¾ in. to 2½ in. The latter mix was decided upon for the arch ring after an elaborate series of tests in the field laboratory located on the site.

The dam has been tried out by the impounding of water in the reservoir as shown in the illustration and has proved non-leakable in every detail. Such water as did come through was easily traced to small fissures below the foundation setting and as a consequence the leaks were soon properly disposed of.

The dam was designed by the writer under the direction of H. C. Vensano, civil and hydraulic engineer of the Pacific Gas & Electric Company. The construction work was handled by J. H. Martin, superintendent of construction, and E. M. Whipple, division engineer. P. M. Downing had active charge of all the work on the Spaulding Development and served as chief engineer with F. G. Baum as consulting engineer.



A Portion of the Spaulding Development, showing Rock Creek Dam in its Relationship to the Wise Power House which is Power House No. 5

THE MANUFACTURE OF OXOGEN AND HYDROGEN

BY F. D. WEBER

(New industrial processes for the utilization of the vast hydroelectric energies of the West are constantly disposing of central station loads in ever-increasing quantities. Here is a description of an oxygen-hydrogen manufacturing plant at Portland, Oregon, which is not only developing in itself a most desirable central station load, but by the appearance of oxygen and hydrogen in Western markets at reasonable selling prices, it is thereby creating by-product industries in the utilization of oxygen and hydrogen in new and hitherto unattempted recoveries in this section of the country and as a consequence offers a possibility of accelerating central station sales in a geometric ratio.—The Editor.)

During December, 1915, a new industry was started in Portland, Oregon. It was the electrolytic manufacture of oxygen and hydrogen. This was one of the first of its kind installed on the Pacific Coast.

From the central station standpoint it is excellent business as the load is constant, 24 hours a day, and for 365 days a year.

To electrolytically manufacture oxygen and hydrogen, water is heated in the boiler and the steam is allowed to pass through coils in the base of the gas holders, which are sealed with water. This causes condensation of the steam, which is led into a small iron tank in the cell room. The cells are filled with this distilled water, together with 85 pounds of caustic soda per cell. The caustic soda lasts indefinitely and replacement is not necessary.

Fifty Cells for the Electrolytic Manufacture of Oxygen and Hydrogen

This new industry at Portland, wherein oxygen and hydrogen are manufactured by electrolysis, illustrates the many new applications of central station load throughout the various sections of the West. Such industries are not only valuable in themselves, but the constantly increasing activities set in motion by the appearance of their products in the market offer even brighter prospects for future hydroelectric development in the West.

The cells are connected in series electrically and it takes 400 amperes at 112 volts to operate 50 of them. When the current is applied, the oxygen and the hydrogen immediately begin to be generated and are brought out of the cells through a water seal into different pipes. These pipes connect to all the cells and lead into the gas holders, twice as much hydrogen being generated as oxygen. When the water level in the cells is down, more distilled water is added in order to keep the water level up to the proper height.

The capacity of this plant is 4400 cu. ft. of oxygen in 24 hours and 8800 cu. ft. of hydrogen during the same period. Twice as much compressor capacity is installed for the oxygen as the hydrogen. Due to the explosive nature of oxygen the compressor lubrication is composed of castile soap and boiled water, as the oil would make an explosive mixture with the oxygen.

Compressors are used to charge the cylinders in which the gas is sold, there being two sizes used, one containing 100 and the other 200 cu. ft. respectively at a pressure of 1800 lb. at 70° F. The use of compressors plays an important part in an industry of this nature and the high pressure under which they operate necessitates careful attention in maintenance and operation.

The Portland Fire Department use small cylinders for fire fighting helmets, which are also charged at 1800 lb. The oxygen generated by this process is 99.7 per cent pure, which is the purest obtainable.

The hydrogen generated is used for various metal cutting processes when combined with oxygen. Recently a new process has been developed commercially for combining hydrogen with vegtable and animal oils in order to purify and refine these oils. This opens an immense field in the Northwest, especially when the salmon cannery waste can be utilized. Hydrogen until of recent years has been a by-product without any market, but now is salable as readily as the oxygen.

The hydrogen flame for cutting steel is more satisfactory than the oxyo-acetylene as it does not carbonize the plates. It will also cut thicker plates.

When the plant was first created only one-half of the cells were installed and half of the generator capacity was used. At present all 50 of the cells are used 24 hours a day and every day of the year. About April, 1917, the plant will be again doubled in size, making a total installation of one hundred cells.

The buildings in this plant consist of a one and two story frame structures; one containing all the equipment except the boiler. The main building has a concrete floor for the generating cells and the other machinery to rest upon. This building also contains a small office, charging racks for tanks, and warehouse, steam heat being used throughout. In the electrical equipment is to be found one Westinghouse motor gas set, consisting of one 75 h.p., 440 volt, 3-phase, 60 cycle, 1150 r.p.m. induction motor, direct connected to a 50 kw. 55-110 volt, 455 amperes, 1150 r.p.m., d.c. generator.

A Westinghouse standard slate motor generator central switchboard panel is equipped with over and under load trip coils and reverse current relays to

protect the generator from reversal of current in the cells.

Two 15 h.p. Westinghouse 110 volt d.c. motors are belted to shafting to operate air compressors. There are fifty International Oxygen Company's oxygen-hydrogen cells, Type 200 D.

The mechanical equipment consists of three Platt Iron Works air compressors, size 4½ by 3½ by 1 5/16 by 6, one 10 h. p. upright steam boiler; one 200 gallon water tank; one 5000 cu. ft. oxygen holder, and one 500 cu. ft. hydrogen holder

THE INTERNATIONAL METRIC SYSTEM

In order to forward the wide publicity campaign for an early adoption of the metric system, the following compilation of equivalents by the National Electric Light Association should be useful:

Table I.—International Units

(1) Amperes	(15) Years
(2) Volts	(16) Months
(3) Ohms	(17) Weeks
(4) Voltamperes and kilovoltamperes	(18) Days
(5) Watts, kilowatts and myriawatts	(19) Hours
(6) Kilowatthours	(20) Minutes
(7) Candlepower	(21) Seconds
(8) Watts per candle	(22) Dollars, cents and mills
(9) Lumens	(23) Dollars per year, month, week, day, etc.
(10) Lumens per watt	(24) Dollars, cents and mills per kw. hr.
(11) Revolutions per minute	(25) kw.-hrs. per year, month or day.
(12) Degrees (of arc)	(26) Kilograms
(13) Degrees centigrade	(27) Centimeters
(14) Cycles per second	

Table II.—Non-International Units and Their International Equivalents

Unit	Equivalent
(1) Acres	sq. m. or hectars
(2) Acre-feet	cub. m.
(3) Amperes per sq. in.	amp. per sq. mm.
(4) Amperes per 1000 cir. mils.	amp. per sq. mm.
*(5) Barrels (of oil)	Liters or hectoliters
*(6) Barrels (of apples) per year.	Liters or hectoliters per year
*(7) Boiler horsepower	kw
(8) British thermal units	watthours or kw.-hrs.
(9) British thermal units per hr.	watts or kw.
(10) British thermal units per lb.	watthours per kg. or kw.-hrs. per kg.
(11) British thermal units kw.-hr.	numeric
*(12) B. and S. gage of wire	mm.
*(13) Bushels (corn)	liters
*(14) Bushels (oats) per year	liters per year
(15) Cubic feet	cub. m.
(16) Cubic feet per sec. per hr. and per day	cub. m. per sec, per hr., per day
(17) Degrees Fahrenheit	deg. Cent.
(18) Degrees F. per hour	deg. Cent. per hr.
(19) Dollars or cents per acre	dollars or cents per sq. m. or hectar
*(20) Dollars or cents per bbl.	dollars or cents per liter
*(21) Dollars or cents per ton	dollars or cents per kg. or per metric ton
(22) Dollars or cents per 1000 lbs.	dollars or cents per kg. or per metric ton
(23) Dollars or cents per front ft.	dollars or cents per front m.
(24) Dollars or cents per lb.	dollars or cents per kg.
(25) Feet	m.
(26) Feet per sec.	m. per sec.
(27) Foot-candles	m. candles or milliphot
*(28) Gallons	l'ters or cu. m.
*(29) Gallons per day	liters or cub. m. per day
(30) Inches	cm.
(31) Miles	km.
(32) Miles per hr. or minute	km. per hr. or per min.
(33) Pounds	kg.
(34) Pounds per hour, day or year	kg. per hr., day or year
*(35) Pounds per gallon	kg. per liter
(36) Pounds per square inch or sq. ft.	kg. per sq. cm. or per sq. m.
(37) Pounds per kilowatt hr.	kg per kw.-hr.
(38) Square in., square ft. square yds., square miles	sq. cm.; sq. m.; or sq. km.
*(39) Tons	kg. or metric tons
*(40) Tons per acre	kg. or metric tons per sq. m. or hector

It has been assumed in preparing the above Table that whenever two units which differ in name are in simple decimal ratio, they are virtually one and the same. Thus dollars and cents are virtually the same unit of currency because a sum of money expressed in one is numerically the same as that expressed in the other after a shift of the decimal point. On the other hand, pounds, shillings and pence are different units.

SUGGESTIONS FOR OFF-PEAK HOURS—II

When next your friends call or you call upon them and you want to enliven the off-peak hours with shouts of laughter and dispell that grouch which has been hovering over your face for some time past, try the following little prescription:

Buy a thirty-cent box of marshmallows and about twelve feet of clean white cotton string. Tie a marshmallow to the center of the string and ask two lady guests to place the ends of the string in their mouth and at a given signal start to eat the string until the marshmallow is reached, the one arriving at this goal first to have the box of marshmallows as a prize. Shades of fallen dignity and short-circuiting of high powered transmission lines! The shrieks of laughter and side-splitting fun that will result will store up in your system a smile and a happy, pleasant feeling that will carry you over many a period of heavy care in peak load hours of the day.

A NEW ELECTRICAL FURNACE AT SALT LAKE CITY

The American Foundry & Machine Company of Salt Lake City have installed an electrical furnace for producing steel castings. This new installation was designed by Iowan Renerfelt, a Swedish engineer. The furnace occupies a space seven feet by nine feet by nine feet high and weighs about seventeen tons. It has a capacity of three tons, producing eighteen tons of steel per day.

The electrical furnace is lined with magnesite brick, with chrome brick bottom, with closely fitting charging and casting doors at opposite ends of the chamber. The electricity is admitted by the electrodes one from above, and through the opposite sides of the furnace, adjustable by hand. This enables the operator to run it independent of the size of the charge, or with arcs in contact with the metal if so desired. The electrodes inserted through the sides, on being adjusted, touch each other, and as they are drawn apart, the electric flame leaps from one to the other, increasing in intensity and temperature as the distance increases while a vertical flame from the upper electrode, forces the horizonal flame down on the charge, forming an arc. This form of arc has hitherto been unknown to electric furnaces, and is one of the reasons for success of the Renerfelt type. This furnace is practically a large internally heated crucible, charged with cold metal.

The superiority of this process over the open hearth or Bessemer converter process is claimed to be a much higher grade of steel, a valuable factor in this being that the heat can be absolutely controlled which, it is stated cannot be done in an open hearth furnace. Further, there is no oxidation which results in a freedom from the presence of objectionable gases, technically known as "occluded" gases. It is said there are but six units of gas in the electically operated furnace steel, to 50 and 60 units in the steel manufactured by the older processes. The slag introduced to draw out impurities, is artificial, two applications being generally necessary, resulting in a greatly improved product. The American Foundry & Machine people are delighted with the results of this furnace.

RECENT RULINGS ON UTILIZATION SAFETY ORDERS

(Electrical utilization safety orders have been the talk of the hour during the past six weeks not only in California, but in other sections of the West. Here is a series of questions and answers of timely import that should be read by all electrical contractors and others throughout the West who are in any way handling the problems of utilization of electrical energy. These notes have been arranged by the California Section of the Electrical Inspectors' Association co-operating with the Industrial Accident Commission of California through its electrical engineer, Robert L. Eltringham.—The Editor.)

Queston 1: Are externally operated switches necessary for control of temporary motors on building construction? (From one to six months' service).

Answer: When externally controlled switches would be required for the same installation, if permanent, they must be installed on temporary work unless it conforms to the requirements of S. O[1], 730, which requires competent supervision or protection by suitable barriers or warning signs when alive and accessible.

Question 2: Are externally controlled service switches required on electric sign or lighting installation on bill boards?

Answer: No. When the entire equipment of switches, cutouts, etc., is enclosed in a weatherproof locked metal cabinet, not accessible without unlocking, an externally controlled service switch may be omitted provided a wooden platform insulated from the ground is arranged so that access to said cabinet is had only when standing upon the platform.

Question 3: On what motor installations are no-voltage release devices required?

Answer: On all installations where, in the opinion of the Industrial Accident Commission, the physical hazards are not sufficiently well guarded to render the no-voltage release unnecessary.

Application for exemption from the use of no-voltage release should be made directly to the Industrial Accident Commission.

Question 4: Will double pole snap switches be approved on motors up to 30 amperes? If not to 30 amperes, to what capacity?

Answer: It is assumed that the question refers to the switch located at the motor or control devices.

Double pole snap switches on motors are permitted.

(1) When used only to disconnect cutouts for purpose of re-fusing;

(2) When used on motors whose starting current does not require the use of auto-starters or compensators;

(3) When used to disconnect leads to auto-starters or compensators whose construction requires a switch ahead of the device.

Snap switches are approved for 30 ampere, 250 volt triple pole capacity.

There is no restriction of size for motor use within the capacity of the switch used.

Question 5: How may exit and hall lights be connected ahead of service switch and on a single meter with balance of building load?

Answer: Installation shall be made as follows:

Main service switch (located where wires enter the building) and cutout shall be inclosed in approved cabinet with door kept securely locked. Thence through meter and branching to two switches and cutouts. First, a service switch and cutout located as required for accessibility, inclosed when so required by the Safety Orders, and controlling entire house load except exit and hall lights. Second, a similar switch and cutout controlling exit and hall lights and inclosed in an approved metal cabinet with cover fastened on with bolts or machine screws.

Main service switch and cutout shall have the capacity of and be fused to 125 per cent of the combined capacities of the service cutout and exit light cutout. Service switch and exit circuit switch to correspond with respective fuse capacities.

In an installation made as above, the "service" switch shall be used for all purposes required of a "main" service switch on the usual installation.

Cabinets required above shall have a legible warning against removing fuses before switch controlling same is opened, which shall be placed on the outside of the cover.

Question 6: Is it the purpose of the Safety Orders to require externally controlled switches on all utilization equipment?

Answer: (a) No. The orders require the use of externally controlled switches only when used on circuits of over 150 volts to ground or when installed in damp places or where local conditions entail a particular hazard.

(b) Switches installed to allow disconnection of cutouts for re-fusing, whether located at distributing centers or adjacent to control devices, need not be externally controlled unless within the restrictions of paragraph "a" above.

(c) Switches used in lieu of auto-starters, compensators, etc., for control or operating purposes, shall be externally controlled if within the restrictions of paragraph "a" above.

(d) Anto-starters, compensators, etc., are accepted as externally controlled devices. No switch is required ahead of them when they are so arranged as to entirely disconnect the current from all fuses when in the "off" position. When not so arranged, a switch is required immediately ahead of device to disconnect fuses while re-fusing. (See paragraph "b" above.)

(e) Fuses are not required on auto-starters, compensators, etc., if equipped with a satisfactory overload release device.

Question 7: Is an externally-controlled service switch required on all installations except flats and dwellings?

Answer: Yes. Order 737 (a) as revised requires a switch, regardless or voltage, ahead of cutout "in basements where concrete floors exist, or where dampness is prevalent at any or all times, or where the operator may have to stand on grounded surfaces in order to re-fuse the cutout."

Order 740 (a) requires an externally-controlled switch in all damp or hazardous locations.

The department holds that, as service switches are placed in practically all installations in the basement, tradesmen's entrance, or some other damp or dark situation that a general rule requiring externally-controlled switches is fair to all concerned.

In flats or dwellings, externally-controlled switches are not required.

Question 8: In what installations are locking devices required on switches controlling utilization equipment?

Answer: (S. O. 736 e). In all installations where it is possible to come in physical contact with moving parts of the motor or devices connected thereto. Where such moving parts are properly guarded, locking is unnecessary. (The adequacy of such guards can be passed upon only by the inspector of the Industrial Accident Commission, when guards are submitted in lieu of locking the switch.)

The device shall be a substantial mechanical contrivance with lock and key so arranged that the switch cannot be operated when locked open except by use of the proper key.

Question 9: What constitutes an "approved" electrical appliance for use in San Francisco?

[1]The abbreviation S. O. is used to designate "Safety Orders" referring to the Electrical Utilization Safety Orders of the California Industrial Accident Commission.

Answer: Ordinance 2582 requires that "....., electrical wires, fixtures, appliances, apparatus or construction ..... conform with the best known general standard existing at the time ....."

The National Electrical Code is the standard thus specified. Compliance with the Code and approval by the Underwriters' Laboratories are necessary under the standard.

The Safety Orders respecting electrical work issued by the Industrial Accident Commission are effective in San Francisco and superior to any conflicting local requirement. The commission approves devices only for "function" with respect to the Safety Orders, and does not examine such devices for electrical or mechanical requirements.

The department therefore requires, first—the approval of the laboratories on all devices to comply with the Code; second, the approval of the Industrial Accident Commission as to function on all devices installed within the requirements of the Safety Orders.

Pending submission to the laboratories locally made devices may be installed if temporary approval is given by the local representative of the laboratories, which approval is accepted by the department. (This representative is the Chief Inspector of the Board of Fire Underwriters of the Pacific.)

Question 10: What grounding is required to comply with Order 703 in inside work?

Answer: Service entrance conduit shall be grounded inside the building with separate ground wire not connected to neutral ground. Shall be No. 6 B. & S. gage copper where wires in conduit are not larger than No. 0 and need not be greater than No. 4 for larger wires.

The neutral wire of all 3-wire secondaries, except 3-phase and d.c. shall be grounded ahead of the service switch and inside the building with an insulated copper wire of size indicated by main service cutouts. Ths ground shall always be run as a separate conductor from neutral to ground. (D.C. neutrals shall not be grounded within a building.)

Neutral ground wire shall always be installed as required for a current-carrying conductor. Unless run in approved conduit, it shall be protected by porcelain bushings through walls and partitions and installed as required for knob and tube work. When run in conduit, the conduit shall be grounded, preferably by bonding to the service conduit, or the service conduit ground wire.

All utilization equipment shall be grounded when connected to circuits of over 150 volts to ground. This requires all d.c. motors to be grounded, for the reason that d.c. power service is obtainable in San Francisco at over 150 volts to ground.

All metal conduit, metal moulding and metal armored cable and cord shall be grounded with copper wire of size indicated by cutouts protecting the wires contained therein. to ground, and less than 300 volts potential requires a separate ground, on the frame or case of the utilization equipment.

More than one ground wire may be run in the same conduit or one wire of sufficient size to equal the total carrying capacities of the connected ground wires may be used as a bus ground conductor, if grounded at more than one place. The neutral ground and the service conduit ground shall not be run in the same conduit with grounds for building installation or utilization equipment. The neutral ground and service conduit ground may be run in the same conduit, the neutral ground being an insulated wire.

Bare wire (except for neutral ground) may be used. Ground wires must be run in a substantial manner but need not be run as required for a circuit wire. Protection where required, such as boxing-pipe, guards, etc., must be installed. Wires must also be located when possible that theft is difficult.

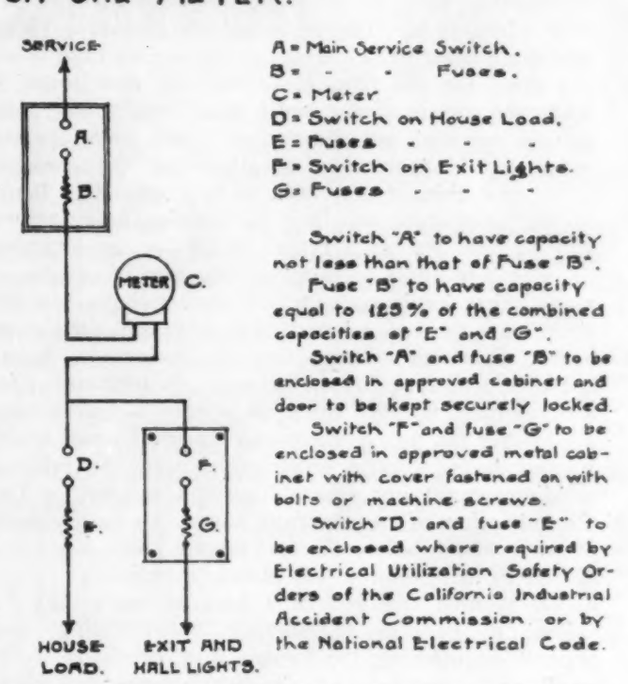
Ground wires (except service entrance conduit) shall be

No. 10 for cutouts of 0 to 50 amps. capacity.
No. 8 for cutouts of 51 to 100 amps. capacity.
No. 6 for cutouts of 101 to 200 amps. capacity.
No. 4 for cutouts of 201 to 500 amps. capacity.
No. 2 for cutouts of 501 to 1000 amps. capacity.

UNDERWRITERS NOTES FOR SERVICE INSTALLATION IN THEATRES

BY C. W. MITCHELL

On account of the increased cost to the consumer due to the State Railroad Commission's ruling regarding rates where two meters are installed, as in theatres, for example, it has been deemed desirable to arrange a method whereby the entire load could be measured by one meter.


METHOD OF INSTALLATION OF SERVICE SWITCHES AND FUSES FOR THEATRES AND OTHER PLACES HAVING EXIT AND/OR HALL LIGHTS, WHERE ALL ARE TO BE ON ONE METER.
SERVICE
A
B
METER
C.
D.
E.
F.
G.
HOUSE LOAD.
EXIT AND HALL LIGHTS.
A = Main Service Switch.
B = - - Fuses.
C = Meter
D = Switch on House Load.
E = Fuses - - -
F = Switch on Exit Lights.
G = Fuses - - -
Switch "A" to have capacity not less than that of Fuse "B".
Fuse "B" to have capacity equal to 125% of the combined capacities of "E" and "G".
Switch "A" and fuse "B" to be enclosed in approved cabinet and door to be kept securely locked.
Switch "F" and fuse "G" to be enclosed in approved metal cabinet with cover fastened on with bolts or machine screws.
Switch "D" and fuse "E" to be enclosed where required by Electrical Utilization Safety Orders of the California Industrial Accident Commission or by the National Electrical Code.

Graphic Instructions for Service Installation in Theatres

The illustration shows such a method and is correct except that the paragraph describing the enclosure for main service switch and fuses should read as follows:

"Switch 'A' and fuse 'B' to be enclosed in approved cabinet and door to be kept securely locked or sealed."

For the purpose of sealing this cabinet a metal seal such as the "Metropolitan" will be accepted.

Large Utility Earnings.—Reports of 325 public utility corporations to the Financial World show for 1916 a total gross revenue of $1,223,006,181, an increase of $227,945,649, or 29.25 per cent over 1915. Net earnings were $550,920,933, a gain of $158,171,953, or 20.24 per cent over 1915. The companies have $2,864,325,700 outstanding bonds, $963,377,500 preferred stock and $2,506,637,835 common stock.

WOMEN IN THE ENGINEERING INDUSTRIES

("Women in the engineering industries" is a subject that is receiving far too little attention in the present national crisis. Below is an account of some of the marvelous things that British women are accomplishing to assist their government through the present troublous times. Serious thought should be given to this problem in these days of preparation. A little training and emergency education at this period, under skillful advice while service may be still made as helpers, will aid much when the test comes later.—The Editor.)

Our British cousins are some two or three years ahead of American citizens in solving the problems of industry and engineering activity brought on by the great European conflict. The Electrical Review of London has recently discussed the question of women in the engineering industries which is abstracted below that doubtless will prove interesting to engineers throughout the West:

The manner in which women have come to the assistance of the empire in taking the places of men of fighting age and fitness and in facilitating the most necessary work, must fill us all with admiration, but it is of the greatest possible importance that the movement, with its magnificent record should not stop where it is. There is need for the employment of female labor to be carried much farther than it has yet gone for the number of fighting men must be increased continuously until the enemy has been utterly defeated, yet the output of munitions for our men must be maintained at all costs. Of course, it is no new thing for women to be engaged in lamp-making, armature winding, accessories manufacture, and so one, but at a recent exhibition in England, there was brought together a collection of articles of many other kinds upon which women have brought their now proved adaptability and deft fingers to bear. Sparking plugs complete magnetos, lamp-holders, armature parts, lighting switchboards for mechanical transport work ad scientific instruments, are among the purely electrical examples upon which women have worked either at drilling or milling, winding, engraving assembling and so forth. But the collection of photographs carries us into classes of labor where before the war female labor if not unknown in this country was almost a curiosity. They depict women engaged in a host of operations involved in general engineering, ship-building, and marine engineering, tool-room and precision work, small arms works, and the manufacture of parts of internal combustion engines. They show them engaged on wiring and rolling mills, operating all kinds of lathes and similar machinery, building small commutators, operating presses for armature work, assembling ironclad switchgear, erecting switchboards, driving 40-ton cranes, in charge of motors on industrial installations, driving electric trucks, electrically welding electric contact mines, operating a 500 kw. switchboard, and attending a 300 kw. direct coupled engine set and a 1000 h.p. steam engine.

Fear and suspicion on the part of male workers as to the position of certain classes of trades after the war, consequent upon the change, still lurk beneath an apparently calm surface; unwillingness and want of conviction as to the suitability of women for certain classes of work still mark the attitude of some employers; and many women continue to show a predilection for classes of service which normal times have proved to be their natural avocations. But we are governed today by the dictates of absolute necessity, and for the time being all will do well to pack up their prejudices, as the soldiers do their troubles, and find a way for doing their bit to further, in the interests of the great cause of Civilization, the employment of women in the engineering factories of the United Kingdom.

If the call of the war office is for men of fighting age and fitness, that of the ministry of munitions is for women, more women, and still more women for our factories in order that those fighting men may do their part with a minimum loss of life, and by hastening the end save millions of treasure also.

Our after-the-war problems may seem to be increased with each successive step forward in disorganization, but who can show suitable alternatives to present methods? Further, may it not well happen that instead of being detrimental to the national industrial situation that follows the war, the availability of a vastly larger volume of skilled and semi-skilled female labor will be an asset of immense value when we resume the manufacturing operations of pre-war times on what we hope will be an exceptional scale, calling for the co-operation of all the demobilized fighting men, and all the new industrial women, in the building up of greater industries than have ever been ours in the past?

WHAT AN ENGINEER CAN DO IN HIS COMMUNITY

In a recent address before the Third Annual National Convention of the American Association of Engineers, Gardner S. Williams, the well-known consulting engineer, in speaking of service the engineer may render, said:

"What can you do?" You can make yourself an influence in your community. Your education entitles you to be a leader of thought among your fellows. Your training teaches you accuracy of mind and body and enables you to analyze propositions and deduce correct conclusions. Your place is in every public assembly, at your party caucus, and at your country's polls on election day. Establish and maintain local organizations, if only in your ward, to bring together the engineers for the purpose of discussing the questions of the day; not merely engineering questions but every question which agitates or interests the citizenship, and when you have come to a conclusion to which you are ready to subscribe, go out and fight for it before the public, in your caucus and at the polls, and let the people know that you are one of two hundred thousand of the best trained, most capable citizens of the republic, who is doing his duty by his fellowmen, by his profession and by himself.

Such service as this on the part of all during these troublous times will aid much in bringing to an early conclusion the present world war.

DEFINITE TIME INTERVAL DEMAND METERS

BY W. A. HILLEBRAND

(Definite time interval meters have found quite extensive application as demand meters throughout various sections of the West. Here is an article that classifies the various meters of this time and discusses their particular fields of usefulness. This discussion is the final instalment of three articles on the subject of demand meters by the author, who is a well-known authority on this line of investigation with the engineering staff of the Pacific Gas & Electric Company. The other two articles were published in the issues of May 1 and May 15, 1917.—The Editor.)

All demand meters of the definite time interval type integrate kilowatt hours over a definite interval of time, and are therefore auxiliary to a watthour meter, on some part of whose register, see Fig. 11, is generally mounted a cam or rachet wheel that actuates

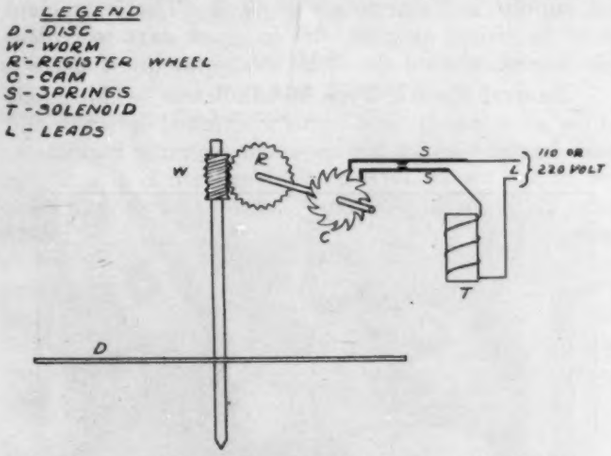
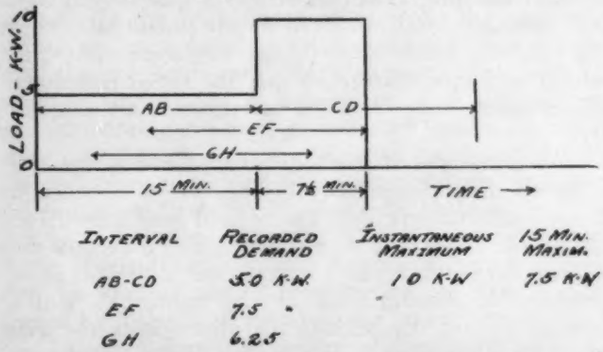


Fig. 11. Attachment to Watthour Meter for Definite Time-Interval Demand Meter

two contact springs. The contact of these springs operates a solenoid T, which operates some form of indicating or recording device, each contact and operation representing a definite number of kilowatt hours. The further duty of the demand indicator proper is to add the number of these contacts occurring in a definite interval of time and to record the maximum of such number.

Nearly all meters of this class have a characteristic fifteen minute load of 5 kw. followed by a steady seven and one-half minute load of 10 kw. which then drops to zero. The fifteen minute maximum is 7½ kw., but the demand meter may record anything between 5 and 7½ kw., according as its interval happens to coincide with intervals AB and EF respectively. That is, only by accident will the interval of the meter coincide with a single peak of duration comparable to the time element of the meter, and, on a varying load, the tendency of the meter is always to under-record.



INTERVAL	RECORDED DEMAND	INSTANTANEOUS MAXIMUM	15 MIN. MAXIM.
AB-CD	5.0 K.W.	10 K.W.	7.5 K.W.
EF	7.5 "		
GH	6.25		

Fig. 12. Typical Performance of Definite Time-Interval Type of Demand Meter

At very light loads the contact springs may be together for an indefinite period, which unless a special circuit interrupter is provided, keeps in circuit the solenoid T which is intended only for intermittent operation, and is generally noisy with a chattering armature.

Fig. 13. Graphometer Chart

The indication is subject to the errors of the watthour meter due to voltage, temperature, wave shape, power factor, friction and miscellaneous accidental causes.

The appearance of a group of meters of this class, including the maxicator, graphometer, printometer and General Electric type M-4, is illustrated in Fig. 15.

Printometer.—This recorder, shown in Fig. 15, operates like a stock ticker, the solmoid operating a set of cyclometer wheels under which passes a paper tape. At regular intervals, controlled by a clock, another solenoid is energized, which causes a rubber platen to strike the paper tape, printing thereon a number corresponding to that registered by the cyclometer wheels. The maximum number of contacts is the greatest difference between any two successive numbers printed on the strip.

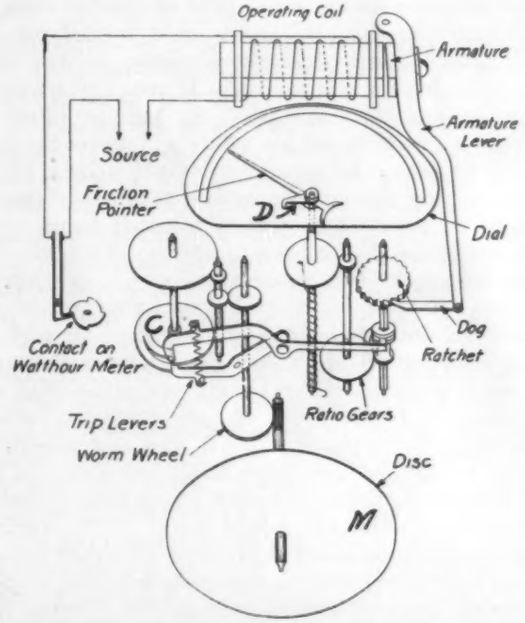


Fig. 14. Plan of Operation of Type M-2 Form AA Demand Indicator

This instrument has the advantage of indicating the day and time at which the peak occurred but is high in first cost, has many parts and contacts and requires time to obtain the maximum reading.

A similar meter is the Ingalls Relay Demand Indicator in which the solenoid punches a hole in the tape for every contact. The demand is obtained by counting the maximum number of perforations in the length of tape travelled during the desired time interval, and the demand so obtained will always coincide with the actual maximum.

Graphometer.—In the original design of this instrument the solenoid actuated a carriage carrying a metal stylus that was carried vertically across a slowly moving strip of paper. At regular periods the carriage would be dropped to the zero position, giving a record similar to Fig. 13, in which the height of any vertical line represents the number of contacts in the preceding period. The advantages of this meter were

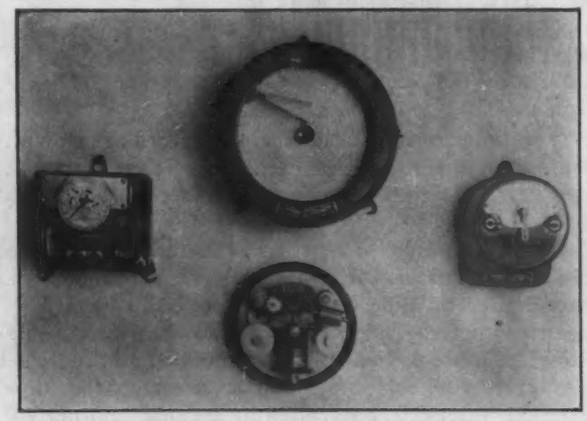


Fig. 15. Typical Appearance of Instruments of the Definite Time Interval Design

a graphic record that was easy to read and slow speed of chart. In this form it is no longer in production but has been superseded by a circular chart design with an eight-day clock, as shown in Fig. 15.

Maxicator.—The maxicator represents an interesting modification of the usual type of definite time interval meter in that, by means of a special register mounted on a standard watthour meter, the disc itself is made to drive a dog which in turn urges a friction pointer over a circular scale. At regular intervals, governed by a timing device, a solenoid resets the driving dog to zero. Its maximum travel in any period is indicated by the pointer, whose reading is proportional to the greatest number of kilowatt hours registered during the desired time interval. The principal difficulties with the maxicator were mechancial, although it is open to the objection that where the resetting of the driving dog is controlled by a clock, a brief interruption of the power supply at the right time will prevent the resetting operation with the result that the registrations of two successive periods are added. The consumer who is wise and unscrupulous can accomplish the same thing and discredit the meter by opening his main switch at the proper time.

The same objection would apply to the various forms of graphic indicator previously described but for the fact that where anything goes wrong with a graphic instrument, the graph itself generally shows the fact and when it occurred. Furthermore, the record previous to the trouble is not destroyed and may serve for billing purposes.

Westinghouse Type RA.—This development is quite similar to the maxicator in that a special register is attached to a standard watthour meter, see Fig. 16, which, instead of moving a pointer over a circular scale, moves a pen over a paper chart. The resetting is done mechanically by the clock that marks the time intervals. Clock and meter are self contained in a single case.

The principal advantage is the elimination of electrical contacts. Possible sources of trouble are due to additional load on the watthour meter, failure of the ink supply, and inaccuracy of clock. The instrument must be visited at least once in seven days to replenish the ink, rewind the clock, or renew the chart.

General Electric Type M-4 Indicator.—This is one of the most widely used forms of demand indicator and was designed as an improvement over the maxicator.

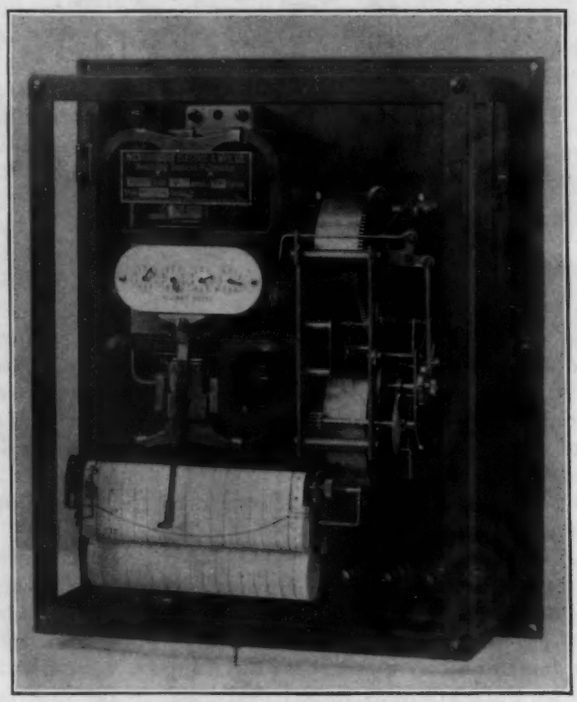


Fig. 16. Westinghouse Type RA Demand Meter

Its particular novelty consists in the fact that the timing device for use on alternating current circuits, instead of being a clock, is a constant speed electric motor, consisting of a copper meter disc driven by a field similar to that produced by the potential element of a watthour meter. It is ingeniously compensated for voltage and temperature so that the speed is remarkably constant under extreme variations in either quantity.

An early type of this indicator, known as the M-2, is shown diagrammatically in Fig. 14. The solenoid through an armature, dog, ratchet and gear train drives against the resistance of a coiled spring a second dog and friction pointer which moves over a circular scale. Resetting is accomplished by the motor, M, which, through a cam, C, periodically disengages the two

ratio gears, permitting the pointer dog, D, to be returned to zero.

Formula

The kilowatt demand is obtained from the registration as follows:

Let K = disc constant in watthours per revolution.

R = register ratio, or number of revolutions of watthour meter disc for one revolution of contact cam on the watthour meter register.

T = number of teeth in contact cam.

C = instrument transformer constant.

D = indicator reading in divisions.

E = time element in hours.

Then

$$\text{kw demand} = \frac{RKC}{1000\,TE} \times D$$

in which D is the statement and $\frac{RKC}{1000\,TE}$ the billing constant applied by the bookkeeper.

This instrument has been widely used, due to the fact that it is inexpensive and is supposed not to require attention. However, troubles with it have been as numerous as the parts displayed, and the writer doubts if they can ever be entirely eliminated, although with intelligent supervision and careful attention this meter is rendering fair service. The remarks made on the dial of the R O meter apply equally well here and the same care should be exercised in securing deflections that are well up the scale.

Owing to the fact that the motor runs continuously, and to the considerable weight of the moving element, bearing wear is much greater than in the watthour meter and diamond jewels should invariably be used instead of the standard sapphire.

Due to inherently different characteristics, meters of different types when placed on the same commercial load will indicate different demands, so that in a very practical sense the recorded demand may be a function of the kind of meter installed. The writer has in mind several such cases, in one of which this difference amounted to as much as forty per cent.

The ideal demand meter would be as simple and reliable as the induction type watthour meter, which is probably one of the most dependable mechanisms ever developed. In rural territory covering hundreds of square miles one man can satisfactorily handle over six thousand watthour meters, but in San Francisco the major portion of one man's time is required to look after about sixty demand meters.

In the foregoing exposition the difficulties with existing meters have been cited in detail in an effort to indicate the problems that confront the man who would design a satisfactory demand meter at a price that the purchaser can afford to pay. The need for such an instrument is imperative, and although no one of existing types is satisfactory under all conditions and for all purposes, it is to be expected that, through co-operative effort by manufacturer and user, dependable indicators will eventually be developed. In justice to the manufacturers, it must be admitted that many of our difficulties with demand meters have been due to the premature introduction of new designs forced by insistent demand of the power companies.

In conclusion, the writer wishes to express his acknowledgments to his associates in the Pacific Gas & Electric Company and in particular, to Mr. Otto A. Knopp, superintendent of laboratory, from whom much of his information has been derived.

RECIPES FOR KILLING FLIES IN CONSTRUCTION CAMPS

Of interest to engineers is any effective method of relieving the fly nuisance in construction camps and elsewhere.

The United States Government makes the following suggestion for the destruction of house flies: Formaldehyde and sodium salicylate are the two best fly poisons. Both are superior to arsenic. They have their advantages for household use. They are not a poison to children; they are convenient to handle, their dilutions are simple and they attract the flies.

A formaldehyde solution of approximately the correct strength may be made by adding 3 teaspoonfuls of the concentrated formaldehyde solution, commercially known as formalin, to a pint of water. Similarly, the proper concentration of sodium salicylate may be obtained by dissolving 3 teaspoonfuls of the pure chemical (a powder) to a pint of water.

Any odor pleasing to man is offensive to the fly and vice versa, and will drive them away.

Take five cents' worth of oil of lavender, mix it with the same quantity of water, put it in a common glass atomizer and spray it around the rooms where flies are. In the dining room spray it lavishly even on the table linen. The odor is very disagreeable to flies but refreshing to most people.

Geranium, mignonette, heliotrope and white clover are offensive to flies. They especially dislike the odor of honeysuckle and hop blossoms.

According to a French scientist flies have intense hatred for the color blue. Rooms decorated in blue will help to keep out the flies.

Mix together one tablespoonful of cream, one of ground black pepper and one of brown sugar. This mixture is poisonous to flies. Put in a saucer, darken the room except one window and in that set the saucer.

To clear the house of flies, burn pyrethrum powder. This stupefies the flies, but they must be swept up and burned.

Borax is especially valuable around farms and out of doors. One pound of borax to twelve bushels of manure will be found desirable as a poison without injuring its manurial qualities or farm stock. Scatter the borax over the manure and sprinkle with water.

Lye, chloride of lime, or copperas (sulphate of iron) dissolved in water, crude carbolic acid, or any kind of disinfectant may be used in vaults.

STATISTICS ON WATER USES IN CALIFORNIA

The first report of the State Water Commission, which is just from the hands of the printer, covers a period from March, 1915, to December, 1916, a little less than two years. Among many other things, it shows that agriculture tops the list for use of water by the overwhelming percentage of 93 per cent of the total amount applied for. Power represented 5 per cent, mining 1 7/10 per cent and municipal supply 3/10 per cent.

A NOTEWORTHY SYMPOSIUM ON RATES

(The subject of rates, whether charges should be on the basis of straight meter measurement or on a flat rate basis or a combination of the two, has long been a perplexing one throughout the West. Here is a discussion participated in by a notable gathering of engineers and central station men of the West that adds much to our present knowledge on this important subject. This symposium on rates as detailed below is the stenographic report of the discussion on this subject in the commercial section of the Pacific Coast Section of N.E.L.A. at the Riverside convention, April 19-21, 1917.—The Editor.)

S. V. Walton: Mr. chairman and gentlemen of the convention, in preparing the report of our committee for presentation at this time, and following the suggestion of President Ballard, I am going to make my remarks very brief. I felt that I had to make a few excuses for the report for myself and for the other members of the committee, but after hearing the very complimentary remarks of Mr. Ballard and the suggestions followed up by your secretary, Mr. Halloran, I won't make any excuses, in fact I feel rather proud of our report.

It is pleasing to me as one of the younger men in the business, one who has devoted all his business years to commercial work, to be given the first paper on the program after the introductory remarks. There is no doubt in my mind that the commercial end of the business is of the greatest importance, has been for some time, and will continue to be more important as time goes on. The first time I was particularly struck with that importance was at the meeting of the National Engineering Congress held in San Francisco in 1915. At that time Mr. F. G. Baum, who is well known to most of you as a technical electrical engineer, presented a technical report, supposedly. That technical report, however, was really a broad commercial report. The keynote of the whole report was the statement made by Mr. Baum that "the civilization of the future will be measured by the number of kilowatt hours consumed per capita." If what Mr. Britton has told us today is true, and I never heard anybody say that he said anything that was not true, California is one of the most advanced states in this country, because here we have the largest consumption per capita of electrical energy of any state in the union.

It is particularly interesting to me at this time to see in the room representatives from all the western states. Not only have we representatives of our own section, taking in the states of Nevada, Arizona, California and New Mexico; but we have a representative of the Northwest Electric Light & Power Association, taking in the balance of the Pacific Coast states, also Montana, Idaho and Utah. That man comes in as a representative of that section. His size of body and size of mind entitles him to represent all the states in that section.

It is not my purpose as chairman to bore you with the reading of our report or any portion of it. Thanks to the Journal of Electricity it has been printed and distributed prior to the time of our coming to this convention.

For the purpose of handling the subject in as brief a time as possible, our committee felt it advisable to divide the subject up. We assigned the sub subjects to different members of the committee who we felt were qualified to handle them, and in that order the subject of Rates was given to Mr. Lemmon. To supplement that, there was a demand for a paper on rates by W. G. Vincent as a rate expert, and he kindly agreed to prepare the paper. The subject of Merchandise was turned over to Mr. Childs of the Southern California Edison Company, a man qualified by experience to handle the subject properly. Electric Heating and Cooking was delegated to Mr. Black of the Great Western Power Company. Unfortunately he is not here. The subject of Industrial Heating was turned over to Mr. Holloway of the San Diego Consolidated Gas & Electric Company of San Diego. To Mr. Walthall of the San Jose Light & Power Company was given the subject of Highway Lighting. The subject of Commercial Organization was handled by Mr. E. B. Criddle.

The recommendations by our committee have been mentioned by Mr. Ballard, and I want to refer to one of them again,—co-operation with other than central station men in our section. It was interesting to me to note on the train that more than fifty per cent of those on the train were representing contractors, jobbers, dealers and manufacturers, and less than fifty per cent representing the central stations. A pleasing thing was the large attendance of members who came from the California Association of Electrical Contractors and Dealers. Their president came down and you will get acquainted with him. They are supporting this plan 100 per cent, and show that we here on the coast are on the right track and possibly a little in advance of the eastern fellows.

I am going to read a paragraph from a letter received the day before I came away, from Mr. Edkins, chairman of the commercial section of the National Electric Light Association, who has also just been appointed chairman of the committee on co-operation between the National Association and the Electrical Supply Jobbers' Association. That meeting was held in New York last month and as a result this committee was appointed. Mr. Edkins says, "It is generally regarded as a milestone in the history of both associations, as this was the first time that representatives of the two bodies had ever met for the purpose of establishing a closer relationship." I think that means a good deal in the industry.

I don't think we can say too much in a complimentary way of the Journal of Electricity, which has done so much in bringing this convention about and making it a success. Without going into personalities, you all have seen the last two numbers of the Journal, the April 1st and the April 15th numbers. You have also received a little baby Journal containing a program of the convention, a few photographs of some of the leading men in the section, and a list of the committees, and also a list of all the registered members. The little leaflet is of great value. I am told they are getting out a daily paper, copies of which will be on distribution tomorrow and Saturday morning, telling about the succeeding days of the convention.

In connection with the discussion of papers, on account of the limited time and to prevent the discussion going wild, it has been thought advisable to limit the discussion of any member to five minutes. Some can say a good deal in five minutes and some cannot say very much. At the end of five minutes of discussion by any member I am going to call time; and if there is a popular demand to give him more time, we will let him go on and say more. Also, those who wish to discuss the paper, should come to the front, because if what you say is of enough importance to be said, we want the reporter of the convention to get it for our proceedings. Each speaker should state his name and the name of the company with which he is connected and also his place of business. That is all I have to say in presenting my report.

President Ballard: Chairman Walton of the Commercial Committee, the meeting is now yours. The time of the session may be extended as long as necessary after five o'clock but not later than six.

Chairman Walton: Now, if any of you want to throw out any of the engineers, it is time to tell them to go out while the going is good. I don't see anybody rushing out. The first paper on our program is a paper on Rates by Mr. W. G. Vincent, Jr., of the Pacific Gas & Electric Company, San

Francisco. The paper is printed in full in the April 15 issue of the Journal, and I am going to ask Mr. Vincent to briefly abstract the paper, and, in doing so to start the discussion.

(Mr. Vincent thereupon presented his report as heretofore printed on page 278, Journal of Electricity, April 15, 1917).

Rates

H. F. Jackson: Mr. Chairman, it strikes me that Mr. Vincent has made an excellent point in emphasizing the two phases of this problem, namely: the theory of rate making as distinguished from the rate itself which is to be handed the consumer. Many of our troubles have arisen from the fact that our rate schedules partake of the nature of formulae in which there are a number of variables which are to be determined for any particular load, and when determined and substituted in the schedules or formulae give the rate per kilowatt-hour applicable to the load in question. What the consumer wants is a simple rate per kilowatt-hour or a block system rate per kilowatt-hour. It is, of course, not possible to quote general rates per kilowatt-hour for all classes of load because of the varying effects of fixed charges, per customer charges and operating charges, but it would seem that we had been leaning too much in the other direction by embodying more or less of the theory of rate making into the published schedules. Every particular case could be analyzed on the basis of the cost of generation, cost of transmission and of distribution, and general expenses, embracing fixed or variable charges dependent upon demand and energy consumption, but the result, while perfectly fair throughout, would be a different rate for almost every consumer and would involve so much computation that we would never serve many customers. It seems to me that most of the essentials could be taken care of, however, by having the rate experts of the various companies classify the business and compute a general block rate for the average conditions of each class. In other words, let the rate experts consider the variables and determine a general rate for the class, which rate would appear in published schedules as a straight kilowatt-hour rate or block system kilowatt-hour rate.

The objection to this lies in the variation of particular customers from average conditions, complicated in some cases by competition from other sources of power, and in others by the presence of an existing isolated plant; or in charges of discrimination between different classes, but, assuming as we must, that the expert will determine the classifications and rates upon the facts without any bias, it seems that the added simplicity of the schedules would more than offset the disadvantages.

John A. Britton: May I say a word? It seems to me that Capt. Jackson is right and Mr. Vincent is right on the question of difference between the theory and practice with consumers, and the reason is this: The consumers of electricity per se, are few who have not been consumers of gas. For over a hundred years gas has been delivered to consumers on a straight meter rate basis, and it has never failed of doing what it started out to do—to accommodate the desire of the consumer to take that commodity. In the first beginning with electricity we did not have any fixed rates. We charged whatever the traffic would bear when our first arc lamp was introduced. Subsequently when meters came into use we adopted a straight meter rate, not knowing anything of the diversity of the uses of electricity. It seems to me that the whole trouble rests in the fact that at the time when the diversity factor was unknown and the load factor was a negligible quantity, that engineers began to study some way to confuse the public by the introduction of rates which the public could not understand and which they themselves very rarely understood after they had made them. (Applause). I made some myself. (Laughter). Now, there was the trouble. As the diversity factor created a better load, the necessity for a rate based upon demand gradually passed away. I think we will get out of this domain of high science and theory and come down to practical facts and we will accomplish a great deal more for our own benefit. In other words, I mean to come back to that question of a straight meter rate. We could not do it with gas if we did not have storage capacity. But when we contemplate the storage capacity of our gas plant as compared to its total daily output, it bears no different relation, to my mind, to what electric companies are able to do today by reason of diversity and the high load factor now being attained, and, I think, the study of the minds of the men who devote time to rate making, would relieve, at least, the companies, and would relieve the commission from a great deal of embarrassment.

Chairman: Reference has been made by Capt. Jackson and Mr. Britton and also by Mr. Vincent to the commission in rather an indefinite way. Those gentlemen living in California refer to the California Railroad Commission. The other states have other commissions. We have some representatives here of the California Commission, and I will call on Mr. Ready of the California Commission.

L. S. Ready: I have not much to say. There is one thing however, I would like to say about the rate schedule. Mr. Vincent mentioned something about their often not being intelligible to the consumer, especially as they are written. I have had the duty of reading over a number of rate schedules in the last several weeks, trying to get some idea of a uniform schedule, and I almost agree with Mr. Vincent. It is quite hard to understand a number of them. Each company has a different way of stating its schedules. Some of them put a great deal more information into the schedule than is necessary; others do not put in enough. I hope that we can work together to get a standard form of schedule which will be as concise as possible, and, at the same time, as inteligible as possibe to the consumer.

A schedule of rates, in my opinion, should be for the information of the consumer. Quite often the solicitor or salesman of a company does not know about the consumer's power requirements and the consumer does not know all about the rate schedule, and the consumer of power, especially, often fails to get the information necessary, in some cases due to the fact that there is so much in the schedule that he never reads it over. I think we can make these schedules a good deal more concise and explicit than a number of them now are and thus assist in giving the information to the consumer. I would say that at least an average of 75 per cent of the consumers of any company are lighting consumers, and one or two schedules is all they are interested in, and they never look at the other schedules. The big difficulties arise really in the power schedules.

Referring to the question of agricultural schedules, it seems to me that we must change to "agricultural schedule" as against the old use of the pumping schedule in order to make the irrigation power business pay. In most of the districts, except where it is used for continuous irrigation, and especially in such districts where the rainfall is from 15 to 20 inches, electric pumping service is an insurance and not a strict pumping proposition. Companies must encourage other business than the pumping load to make the irrigation or agricultural load pay enough to justify its extension. I think future work should be along the line of developing agricultural schedules which will apply to all possible power service on the farm and will make agricultural service a remunerative proposition.

Chairman: The discussion so far from member companies has been from the representatives of what we term larger companies. As brought out by Secretary Halloran, the majority of the membership is made up of smaller companies. There are a great many members that do not live in California. I am going to call Mr. Aller, general manager of the Pacific Gas & Electric Company of Phoenix, Arizona.

H. L. Aller: I sympathize with Captain Jackson and object to being called upon without any preparation. We have had much the same experience in rate making and have followed almost the entire cycle that Captain Jackson

has outlined. We have gone from the simple rate to the complicated rate and have turned back again to the simple rate. When we take into consideration the fact that about 80 per cent of the consumers of the normal electric utility are small consumers, it becomes obvious that to inaugurate a complicated 2 or 3 factor rate for all classes of consumers is merely to court difficulties without any compensating advantages. I believe that if we endeavor to establish a straight meter rate without any demand factor, for all residence consumers and, in fact, for all small lighting consumers, and establish the demand factor and more scientific rate for the large power and lighting consumers only, we will dispose in large part of our difficulties.

We now have a very simple two-block rate for residence consumers and a simple four-block rate for small business lighting consumers without any demand factor. We have an alternative lighting and power rate with a demand factor for large business lighting and power consumers. About 75 per cent of our small business lighting consumers are on the simple block rate.

Prior to the time that we established this simple rate we had endless discussions with the small consumers, trying to explain the equity of the demand factor rate. Since the small consumer prefers to pay his bills under an easily understood rate, he should be accommodated, even though we feel that a slightly more equitable distribution of costs could be effected by a more complicated rate. I believe the time is coming when we will all follow Captain Jackson's cycle and revert to simpler forms of rates.

Chairman: As I said in my early remarks, we have with us a representative of the Northwest Association, I will call on Mr. Coldwell to discuss the question from his point of view.

O. B. Coldwell: Gentlemen of the convention, it looks like this is a put up job. Regarding this matter of rates, in the Northwestern Association we, too, have had numerous papers on the subject and have possibly traveled the same journey which Capt. Jackson mentions. There is one phase of it which we have gone into somewhat and which has not been mentioned so far, and that is the attempt to ascertain some of the fixed charges applicable to the various classes of service, and to ascertain the total cost with the object in view of submitting rates to those costs. I cannot say that our endeavors were altogether successful, but it appealed to me that there is a field there for an engineer which is well worth while. The average central station man, I think it will be found, if the question is put to him as to what it is costing in toto to serve the various classes of service, especially if his company happens to be a combined light and power and railway property, is ready and quite ready, ordinarily, to talk about the matter of operating costs. He knows about those things very well indeed. When it comes to the other part, that is, the fixed charges, he is at a loss and the best he will ordinarily do is to give some approximation. In other words, the matter of apportionment of cost to the various classes of service is something with which he is not altogether familiar.

The commissions have done some work along these lines. It seems to me that it is high time for the central station people to undertake themselves to solve this problem. It certainly has an intimate bearing upon what rates should be. I believe the central station people could very well try to set the pace in that regard rather than follow the commission and the commission's engineers. It goes without saying that the operating men who are actually in the business are better qualified through their intimate knowledge of their operations to carry out such apportionment, than is the engineer of the commission who is handicapped by not knowing the intimate use to which the property is put.

Chairman: I only believe in a modified form of conscription, and unless there are volunteers for further discussion on rates, I will not call on anybody else other than Mr. Vincent, if he wishes to say anything further. Mr. Vincent, would you like to say anything further in closing?

W. G. Vincent: There are one or two points that I would like to bring out. First, I am not advocating a complex schedule or any complicated scheme of rates. I think that at the present what might be called the standard bases of charges which are in use, such as the Hopkinson, Wright, block rates, etc., are sufficiently flexible to take care of any problem or any form of rate curve that may be desired. Second, in regard to Mr. Aller's remark that one consumer possibly pays a little more and another a little less than they should, I believe that this is inherent in any rate schedule. The best that any schedule can do is to approximate an equitable distribution between classes and between consumers and we cannot hope by any general schedule to obtain an absolutely equitable distribution between all individual consumers.

The straight meter rates which have been referred to by several of the speakers may solve your problem from the commercial point of view to a certain extent. I believe, however, that the speakers who have referred to a straight meter rate have not intended to be understood as approving a rate carrying the same charge per kw.-hr. for all consumption, but rather have meant to be understood as charging a rate based entirely on the kw.-hr. used. This, of course, would include block rates. This class of rates used exclusively will not give consumers the opportunity to make the greatest use of our service nor will they permit the greatest possible use of our plants and equipment. These results can only be accomplished by the use of differential rates in one form or another.

H. F. Jackson: May I intrude just a moment longer? It seems to me that if one thing has been pointed out by this brief discussion, it is the fact that we have a very large subject to discuss. It is one to which we can devote a great deal of study. The interest which has been shown would seem to me to indicate the advisability of our getting together in local groups when we get home, to work on this rate problem and to develop something that can be brought back as a basis for further study by the association. I would like especially to urge that the people from San Francisco get together and talk frankly. They can spend hours on the subject. Let them get the essentials together and see if we cannot from the combined experience of all of us build up something simple enough for the consumer and yet embodying the various elements of fixed and operating charges.

C. F. Butte: I would like to ask a question from the standpoint of a consumer in reference to power installations. Many times we install them and it is hard to get the consumer to understand the minimum rate per horsepower for motors connected. Is there anything in regard to that subject to be taken up, on the minimum charge per horsepower? Many times we will install a larger motor than is absolutely necessary for intermittent service. As an illustration, in a mill we installed some time ago, the minimum rate used at that time was greater than the consumption of the entire mill, and the minimum per horsepower connected was reduced for that reason.

Chairman: Mr. Butte is the president of the Butte Engineering & Construction Company of San Francisco, and an electrical contractor, and one of the members of our association. This particular question is of vital interest to contractors. Has anybody anything to say in answer?

A. G. Wishon: Especially in view of the character of load that is carried by a company like mine, it makes a great deal of difference whether we have a straight meter rate without reference to installed capacity, or whether we have a minimum charge first. I do not think that I would object to a straight meter rate, provided there was sufficient minimum charge. I once had a canvass made along a line out of Fresno, that had eighty-two gasoline engine pumping

plants within a mile of either side of that line. We went so far as to find over a term of years the number of hours that these engine plants had been used for pumping water for irrigation, and found that it was only a few hours each year; that they were not put there to be used except in extreme emergency. They were there as standbys for possible dry years for the Fresno Canal & Irrigation Company —one of the most dependable water rights in the state.

Now, if we go to a straight kilowatt hour basis, without any reference to a standby charge, we are going to face a fixed charge upon the investment in transformers and our lines to reach these people, without any assurance whatever of an income except in dry years, being exactly the time when we are shy of sufficient water for our own operation. Take, for instance, the dry years of 1912 and 1913, when our reservoirs were barely full and our streams were almost dry. If we had been taking on that kind of business, our maximum demand would have been doubled and the very next year would have shown no income from that class of business. We would have stood there as a guarantor for the ditch companies, with a fixed charge that we must meet, without a dollar of income. This is a very serious problem that must always be considered.

On the 1st of January, 1916, 26 per cent of our business was agricultural pumping. I know one of the companies in the state that had more than three times that percentage of that class of business. It will, therefore, not do to undertake to handle that business without a suitable minimum charge as a consideration for fixed charges that the companies must have for service rendered. I once said to a member of the railroad commission—"do you realize that it is just possible that no two companies in this state need of necessity have the same rate? Take, for instance, a company with one class of business predominating, it should have a certain rate to accomplish a certain general result. If any company has a great diversity of business, it can stand nearly anything from any one class, but it could not be be done with the kind of business that we are serving."

I think most of us have overlooked the value of the diversity of our business. Like Captain Jackson, I am willing to back up a little on my theory of this feature. I am even willing to go so far as to say that an established flat rate system is really not a flate rate, but a charge for a maximum demand, which might be superseded by a minimum standby charge and a plus charge for kilowatts used, but the minimum charge must not be too small, for you must have a sufficient sum to cover your investment, operating expenses, and a reasonabe profit, whether they run or not,—something like the insurance companies. They charge a flat rate for the insurance of your property, which many suppose to be a profit of one hundred per cent in the event your property does not burn, but which in fact is a collection of a sum representing the cost of writing that particular class of business and carrying it for a fixed and definite term. We must certainly have a satisfactory annual income as a standby.

When you get away from that feature, my company and other companies with which I am acquainted will suffer greatly. The Pacific Gas & Electric Company, with its big commercial and industrial business, consisting of lighting, mines, dredgers, reclamation, and all that sort of work, gets out of it on diversity factor that makes the results reasonably satisfactory, notwithstanding that one of the items of their business, for instance, reclamation, is a very uncertain quantity. I know of the operation of pumps by that company of very large units, where the business is very intermittent

If such units were operated in the way that they are operated on the islands by a company with the load we are carrying, it would break it. They may have enough other business, however, so that they can stand it because of their general diversity factor, but the percentage of such a load to our total would be fatal to us. So I say that this proposition must, in a way, be approached from the needs of each company and the class of business served by it. We cannot get away from that theory. When I first started in the electric business, twenty years ago, I conceived what I considered the bright idea of charging an annual sum for a fixed maximum demand. If the consumer took a definite part of our installed capacity, the rate charged him was based upon the cost of operation, interest, depreciation, and a small profit on that quantity of our capacity, and he was given the privilege to use it continuously—a thing that the early users of pumping plants accepted in the orange districts.

That worked out pretty well, because we had practically one class of business. We probably did not have more than ten per cent of all other classes combined.

As the San Joaquin built up a diversity of business, we modified this plan by giving seasonal irrigation rates, because the pumping load in the summer time and our lighting load in the winter time were offset. These seasonal rates were also based upon load factor. This whole system seemed complicated, it is true. We tried our best to teach the consumer how the measurements were made, but it was a hard game. Our whole system of commercial and industrial rates were based upon load factor.

In fixing all of our rates the commission did not see fit to leave us this scheme of determination. They based the rate upon a different theory, some of which worked out all right—other parts of which we persuaded them to allow us to change, so that the proposition is at this moment unsettled as to which of the two plans were most satisfactory. But the commission's scheme of rating has the advantage of having the official stamp of the commission, whether right or wrong, and automatically satisfies most of the consumers.

There is this one feature that I hope for and I think the commission will finally come to it, and that is that there is a classification in business that must be known and understood as classification instead of discrimination. The commission accused us of discrimination. I honestly do not see it that way. I firmly believe it to be classification. It is my hope that we may be able to impress upon the experts of the commission the real existence of classification.

All tons are not the same price per ton mile with the railroads. I had an experience in the shipment from a little town near Fresno of lumber at 75c a ton and gravel at 25c a ton in the same class of cars—shipper loading and unloading in both instances. This is classification—pure and simple—well understood by me and, seemingly, by the country at large, because it is an ancient and well understood principle, while the development of the electric business has been more recent and the theories of development have been so varied as to really muddle the subject.

This condition has been brought about by each company having a different theory of rating, there being no standard of hardly any one rate applicable to all companies. The experts of the commission thoroughly understand the classification of railroading, and it is my sincere hope that they will help us to study out classification in our business, realizing the effect upon our systems of the demands of different classes, at different seasons of the year, or different times of the day.

I do not believe that we will ever be able to serve one hundred per cent of all existing business in any district. There are certain standbys that are intended as an insurance against dry years in gravity irrigation districts, that positively will not pay the power companes to handle, some of which are not run one year in ten. I sincerely hope that a study will be made of classification of rates and a solution arrived at as to the difference between classification and discrimination, for it is an important and controlling feature.

John A. Britton: To set myself right, in speaking of the straight kilowatt hour, I had no idea of departing from the

minimum charge for any service at all. That would be a practical impossibility even for us to do.

Chairman: I think the question propounded by Mr. Butte has been side-stepped. His trouble, I think, is where a man installs 75 horsepower and where 50 is all that was necessary, —that he wanted 75 horsepower but would not pay the minimum.

A. G. Wishon: In our business of irrigation, for instance, we have a section of the country with about 400 pumping plants installed where the water goes very deep after the pumping season begins. The recent rulings of the commission were to the effect that we should have a fifteen minute maximum demand to determine the basis of charge for the power used. Now, in our old scheme of maximum demand we did it in a different way, allowing the pump to operate for a few hours until the water level was down to a normal condition, when we then took his maximum demand. In some seasons of the year, it might take us six hours—in others, a shorter period. After the running conditions were determined, measurements would not be taken again until the beginning of another season, when the water level would be higher and the pumps inclined to overload, unless allowed to pump off the top, as stated. In other words, we did not measure except under running conditions.

This same plan was followed with reference to summer business, as in the flour mills, where the journals must be warmed before the heavier starting torque is over. We never did charge them under our old system of maximum demand rating for the conditions under which they were started, but on the other hand, we charged them for the running conditions. In the oil fields the maximum demands occur several times during a day, from thirty minutes to an hour, that makes an unsatisfactory method of determining their rates under the maximum demand rulings of the commission. I think we should be permitted to measure this class of business under the operating conditions without calling it discrimination. We again insist that this is classification—in some instances, a physical condition that cannot be determined by the "rule of thumb."

Chairman: Does that answer your question?

C. F. Butte: The object of the question was to bring out a point in connection with preliminary work where we don't know the exact amount of the prospective load. In several cases we have found that the minimum rate per horsepower for the meter exceeded the consumption during the month. Whether that has been changed or not I don't know. That was my reason for asking the question. It applies more to industrials than to pumping plants.

Chairman: I think the question raised by Mr. Butte is a very interesting one and one that every company has to solve for itself. It is classification.

John A. Britton: I feel apologetic for butting in again, but this is such an important and such an interesting subject that I can't help it. I have run against exactly the problem Mr. Butte is talking about, and it is this. We have had what we considered the most ideal rate, the load factor rate. We have run into the question of a man putting a motor in and penalizing him by reason of his having a little more machinery. That points to a moral. That is the point that we want to get at here. That is the reason why we should come to some kind of a meter rate that will take care of the general situation. It won't be the business of A, as Mr. Vincent has pointed out, or of B. There will be slight discrimination, but on the whole it will be the fair thing. Speaking of the lighting question in the town, all the consumers in the town ought to pay the same rate for the same service, whether they live in the outside of the town or in the center of the town. I mean based upon the rulings of the railroad commission as made and probably upon equity. Therefore we should have something that will get away from this class discrimination of connected load when a man has not the connected load working. I wanted to say that Mr. Wishon unfortunately misunderstood what I meant. We have no idea of relieving the consumer of the minimum charge. What was in my mind was hitched onto the point Mr. Butte has made, namely, by reason of the fact that a man has installed ten horse-power more than he needs he should not be penalized more than the fellow who happened to hit it exactly.

Edward Whaley: I do not reach the same conclusions as Capt. Jackson. A straight kilowatt hour charge cannot equitably meet all conditions of service if it is admitted, as I think it should be, that cost of service, including a proper return on the capital invested, should determine what is a proper charge for service rendered by utility. For example, a minimum charge which exceeds the bill as computed for the number of kilowatt hours used at the straight kilowatt hour rate is conclusive proof that in that particular case the straight kilowatt hour charge has failed to correctly measure the value of the service. If you analyze it closer you will find that the straight kilowatt hour rate will theoretically meet only one condition out of the many that will arise, although it will approximate a great many others. Standby, or readiness to serve charges, which are eminently proper, are practically ignored by the straight kilowatt hour rate.

In the matter of classifying your service and applying a proper rate to each class your problem is no different to that of the man operating a department store. If you will analyze your business sufficiently you will find that you are in the same position as the department store manager who discovers that a dozen departments are making a satisfactory profit but that two or three are making a loss each year.

Mr. Coldwell has pointed out what, to me, is our real problem. We have got to study our business more closely than we have in the past, we have got to take it apart and analyze it closely in an endeavor to lay a proper basis for the classification that Mr. Wishon wants. And this matter of classification, within reasonable limits, is of the utmost importance. A proper classification is the only insurance against discrimination. If you do not properly classify your customers but arbitrarily put them all in the same class, the result is the very essence of discrimination, for the large majority will not pay in proportion to the operating conditions which they create.

Mr. Aller has raised a point which must not be overlooked and that is, that analyze the conditions as closely as we may we finally come to a point beyond which it is not practical to multiply our classifications and that here we have to resort to a study of the average conditions within each classification. Extreme care should be exercised in doing this part of the work, however, for in applying the law of averages to the operations of a large company with a great many consumers in order to determine the results of applying a given rate to any class of consumers the actual results will vary greatly from those in the case of a small company with a limited number of consumers and wherever possible a separate check should be made on a number of individual cases to determine whether the conditions assumed to be average are truly so or only apparent.

A few other points come to mind in this connection. I have nothing to say on them but I wish that some one else would. That is, the value of the service to the consumer and, going very closely with that, the rate necessary to meet competition of some other sort of power.

Chairman: The subject of rates is so big and of so much interest to all of us that we could sit here and discuss it for weeks. The question raised by Mr. Butte is interesting. The fellows of the commercial end of the business are confronted with it every day and a number of times a day. Mr. Britton says that Don't Worry Somers wanted to speak on the subject.

Frank Somers: Along the line of least resistance of making the rates more intelligible to Mr. House and Lot, to whom I sell ranges, we speak of the rate of 4, 2, and 1½ on

active connected load. The average range is 5½ kilowatt. In trying to make ourselves understood by the country customer to whom we are obliged to sell ranges when we cannot sell them gas ranges, we tell the old man that the rate is 4 cents, 2 cents, and a cent and a half,according to the amount he uses, and that the range is 5½ kilowatt, and we arbitrarily place the load at 3 kilowatts active connected load. The active connected load means that the average is only going to be half of the range rate. I know two consumers that live in the country where I do and have the same kind of a range, put in by the same man and put in right—well, no,—I put it in. (Laughter). One of these ranges averages $2 a month. The neighbor has an average of $8 to $8.50 a month. They cannot understand why they pay the same rate. One is practically a retailer and the other a wholesaler. We even try to explain how we arrive at that decision of 5½ kilowatts when the active connected load is 3 kilowatts.

Chairman: Our president has told me that if I did not stop the discussion on rates and get to something else, he would use the big stick on me. But Mr. Kennedy wants to talk and I wouldn't dare stop him.

S. M. Kennedy: I have been listening carefully to what has been said on this most important subject. I believe there is no subject that the commercial man has to deal with that requires more detailed attention than the one of rate making. We talk these days a great deal of scientific rates. As I understand it, that means fixing rates that closely follow the cost. Now, the most scientific schedules that I ever saw were in a certain city in the east. They took into consideration the connected load, the maximum demand, the load factor, the hours of use, and the quantity, and also allowing something for cash payments. I made it my business to go to that city to study that condition, and I had nothing but admiration for those schedules. They were the most beautifully constructed schedules I ever saw, and, as far as I could see, they followed the cost more closely than any other schedules I have studied. At that time I was making a special study of that subject.

But I found something else. After I had studied the schedules in the offices of the power company, I then went out and talked to some of the power company's consumers on my own account. I said I was a stranger from the coast and inquiring about business conditions, and worked around to the subject of rates. I learned there was not one satisfied consumer out of 50 business men that I talked with. I learned that those schedules, which the power companies claimed to be scientific, and while I recognized that they were scientific, it was a fact that they were a trouble and a worry and a cause of soreness, and one of the evening papers was regularly pounding the power company because people complained they did not know what they were going to pay for the energy they were using.

Now, I want to tell you what my conclusion is after sixteen years of this rate-making. I find that it is better for the consumer—it pleases the consumer—and it is better for the power company and it is better for every one concerned, to have a simple schedule. The more simple the schedule can be made, the better it is. We may make schedules that are scientific and follow the cost closely, but we are going to have a great deal of trouble with them. I saw some schedules filed with the railroad commission that would take a Philadelphia lawyer working overtime to analyze and find out from them what the rate for service was. And that is not what the consumer wants. We want to simplify the conditions so as to get the business, and the way to get business is to meet the reasonable wishes of the consumer.

Now, I want to point out another thing. The same rate conditions applying to a small company do not apply to a large company, and what applies to the big company does not meet the requirements of the small company. The reason is the diversity of the load. Nothing has surprised me so much during my long experience as how low we can go with some consumers and how much it costs us to serve others. We must pick and choose between the different classes so that we know the value of the different loads. We must also take into consideration the question of expediency in competition. We must figure on the details of each kind of consumers' business. To a considerable extent, while we may pick out the large consumers and give them special rates and put them in a class by themselves, we must keep our schedules simple and we must learn to take the lean with the fat. We must make it easy for the consumer to understand, and at the same time we must get all the business we can. The large company with a great diversity of its load needs all classes of business. I would take the kind of business Mr. Wishon says he does not want. I would have some kind of system that would take that business on, if it is only seasonal and if it needs service only one year out of four, because of the diversity of the load of my company. The more diversity we have in the load the more we can classify and the more readily we can take on all kinds of business. I don't know any kind of business in Southern California that we want to push to one side and say we don't want it. My company wants it all and we are going to get it all and we are just learning how to get some that we never have reached up to now.

W. S. Leffler, (contributed): I fully appreciate, from the standpoint of gross station revenue, the relative importance which electric heating and cooking rates bear to the power rates, upon which we have just heard such interesting discussions, but before passing on to the next paper I would like to hear some discussion on the very pertinent questions asked by Mr. Vincent in his paper, under the section of electric cooking and water-heating rates.

The questions are: What form of schedule is best? Shall we make a one-meter rate in combination with the lighting load? What shall we make the top rate? Are we justified in making a lower rate for this service than for small power? How can we handle water-heating?

The first question, asking what form of schedule is best: Several years ago, as Mr. Jackson has said, we were at the ultra scientific extreme in our rate analysis and development. Today we are realizing our inability to make rate experts out of our consumers, and are swinging back to the old unscientific, though simple-in-explanation, forms of schedules. Let us not swing too far, because in the meantime we have come under the regulation of a commission whose sole duty is to expert rates, and though I fully appreciate the advantage of the simple rate-forms, still I am of the belief that we can yet develop a form of amplified domestic service rate so simple in its quotation that the consumer may readily comprehend it, yet sufficiently scientific in its nature to induce the consumer to impose upon us only such load characteristics and investment requirements as will entitle him to the low unit rates quoted in the last blocks, and therefore make practicable the operation of that type of cooking and water-heating equipment which will amplify our domestic feeder revenues to the point where the investment thereto dedicated will be developing a net profit as great per unit of load as is derived from other classes of service.

If from the nature of today's discussion we are to conclude that the simple block form of rate will be most generally acceptable and effective, I should wish to point out the value, and, in my mind, the necessity, of considering the consumer's total load, at least to the extent of having the resultant rate quoted in the form of two block rates, each of similar form but applying to a different size of connected load, and so designed as to derive for the central station a gross revenue in direct proportion to the investment necessary to serve the various size loads. A schedule such as the following, is, in my estimation, the simplest form of scientifically-sound rate which can possibly be quoted.

In the following rate-form the unit charges are naturally subject to modification for adaptation to each central station's conditions:

Amplified Domestic Service Schedule for Application to Domestic Lighting, Cooking and Water-Heating Installations

Part I

Where consumer's total connected load does not exceed 7.5 kilowatts:

7c per kw.-hr. for the first 15 kw.-hr. consumed, per meter per month.
3c per kw.-hr. for the next 85 kw.-hr. consumed per meter per month.
1c per kw.-hr. for all over 100 kw.-hr. consumed per meter per month.

Minimum charge: $2.00 per month per meter.

Part II

Where consumer's total connected load does not exceed 12.5 kilowatts:

7c per kw.-hr. for the first 25 kw.-hr. consumed per meter per month.
3c per kw.-hr. for the next 125 kw.-hr. consumed per meter per month.
1c per kw.-hr. for all over 150 kw.-hr. consumed per meter per month.

Minimum charge: $3.00 per month per meter.

Part III

Where consumer's total connected load exceeds 12.5 kilowatts:

7c per kw.-hr. for the first 3 kw.-hr. per month per kw. of connected load.
3c per kw.-hr. for the next 12 kw.-hr. per month per kw. of connected load.
1c per kw.-hr for all over 15 kw.-hr per month per kw. of connected load.

Minimum charge: $6.00 per month per meter.

The most apparent advantage which the above form of rate offers the central station is that it prevents the consumer—such as a dairy farm, for instance, purchasing a range and calling for the present forms of one-meter single-rate quotations to apply to his large lighting load and also the energy consumption of his many small motors, which under the power schedules would earn from 2c to 4c per kw.-hr., but under an amplified domestic service schedule would be granted a rate averaging possibly 1½c per kw.-hr. Further the above suggested rate-form is somewhat in line with the type of rate recommended by Mr. W. W. Briggs in a recent article published in the Electrical World, where the size of each lighting, cooking and heating block was automatically increased as the consumer adds to his total connected load by units as small as 2500 watts.

In the light of today's discussion, the above form of rate will seem a bit theoretical and possibly too scientific, but in my estimation it is the simplest form of rate which can possibly be developed to derive for the central station the monthly revenue which will be in direct proportion to the investment which the company must make and at the same time afford the small consumer a rate, the lighting and cooking blocks of which will not be so out of proportion to his actual kw.-hr. lighting and cooking requirements as to impose an undue burden upon the cost of his water-heating for which the tertiary blocks are designed. It is at once evident that unless some restriction is introduced into the rate in the form suggested, or, on the other hand, by lengthy and complicated definitions and tables of exceptions and limitations, it will be impossible for the central station to develop a revenue in direct proportion to each consumer's demand, for he will not be induced to install that type of water-heating and power apparatus which requires the installation of the least equipment on the part of the power company and also imposes upon the service company's lines the least instantaneous demand, the line disturbances from which can only be eliminated by the installation of high-cost copper and transformer equipment.

The adaptability of this simple form of rate brings us to Mr. Vincent's second question, which asks whether or not a form of amplified domestic service one-meter rate should include a lighting block, or, on the other hand, be developed only for cooking, water-heating and power and therefore necessitate the installation of a second meter to record solely the lighting consumption.

Before discussing the advisability of including the lighting block, I wish to bring to your attention a very important finding indicated in Mr. Vincent's chart for residence lighting, which you will find represents a study made from the consumption records of 3000 residence lighting consumers, and is developed to show not the theoretic mathematical average lighting consumption per consumer, but to show the number of kilowatt-hours which the greatest number of consumers average per month for lighting purposes. To be specific, we find that the mathematical average monthly consumption per domestic lighting consumer is 21.3 kilowatt-hours, which is obtained by dividing the actual gross monthly consumption by the 3000 consumers whose records were investigated.

For the development of the basic lighting block of an amplified domestic service schedule, our first thought would be to use this figure 21.3 kw.-hr. as the lighting block. A more careful study of the chart, however, discloses the fact that this figure is exceedingly misleading and is not applicable for use in the development of a combination rate, the first block of which might be intended to cover the lighting and appliance consumption for the average of the majority of domestic consumers.

Referring to the chart, we find that, of 3000 consumers, only 90 consumers used 21 kilowatt-hours per month. The peak of the curve, coming at 12 kw.-hr. per month, indicates that the greatest number of domestic consumers do not use more than 12 kw.-hr. per month for lighting purposes. Broadening this peak, to adapt it to a practical basis, we find that in the neighborhood of 12 per cent of the consumers use less than 8 kw.-hr per month, and approximately 63 per cent of the consumers do not consume more than 18 kw.-hr. per month. It therefore develops that 63 per cent minus 12 per cent, or approximately 51 per cent of the consumers, produce a monthly consumption for lighting and appliance purposes between 8 and 18 kw.-hr. per month. Or expressing this in a different manner, we might say that more than one-half of the total number of residence consumers use from 8 to 18 kw.-hr. per month, which gives us the practical or majority average monthly consumption of domestic consumers as $(8 + 18)/2$ or 13 kw.-hr. per month.

This figure, then, of 13 kw.-hr. per month, and not 21.3 kw.-hr per month, represents the number of kilowatt-hours which would most successfully adapt itself to use as the lighting and appliance block of a combination domestic service schedule. We find, however, that in the minds of those central stations developing one-meter rates to be applied generally to all classes of connected load, the lighting block is fixed at from 25 to 35 kw.-hr. per month, whereas the greatest number of consumers consume only 13 kw.-hr. per month. This point seems to me the most important factor in the development of a lighting block, and again indicates the necessity of making a small kilowatt-hour block rate for application to small connected loads and a second rate of similar form with larger kw.-hr. blocks for application to the lighting consumption developed by consumers having a larger connected load.

The average of the majority is not the average of the whole. But since our success with the majority is the measure of our success with the whole, the characteristics of the majority should ever be considered as our indices of the whole. If my logic is sound, then Mr. Vincent's third question, which asks what shall we make the top rate, is very simply answered; namely, 13 to 15 kw.-hr., at the prevailing lighting rates, for those domestic installations not exceeding say 7½ kw. total connected load. As noted above, I limit the first quotation of this proposed double-rate form to 7½ kw. because that figure will permit the installation of 1200 watts of lighting, a small range of 3500 to 5000 watts capacity, and the installation of 750 to 1500 watts automatic water-heating equipment.

The second top block can then be made 25 to 40 kw.-hr. at the lighting rate for application to all installations having an excess of 7½ kw. of connected load, the determining factor being the result of a study after the nature of Mr. Vincent's

chart, using data individual to the central station contemplating this form of rate.

The fourth question: "Are we justified in making a lower rate for cooking and water-heating service than for small power." The answer to this, forgetting for the moment the theory of "value of service," which, by the way, is receiving less and less consideration from our regulating bodies, is—we are not justified in making a lower rate for cooking and water-heating service than for small power, i.e., 3 to 5 kw. motors, unless we can specify the installation of such cooking and, particularly, water-heating equipment, the resultant load characteristics of which will earn from the central station a lower unit rate than is earned by the small power apparatus to which, heretofore, has seldom been granted a rate lower than 4c per kw.-hr. That is, if we are exploiting cooking or water-heating devices having 3 to 5 kw. instantaneous maximum demand, which requires the central station to make the same investment as is necessitated by the operation of a 3 to 5 kw. motor or other power device load, then the answer most certainly is that we are not justified in making a lower rate for any domestic device whose load characteristics impose the same service and investment requirements on the power company as small power apparatus, motors, rectifiers, etc.

I think I am borne out in my contention by the recent ruling of the Illinois Commission which, after hearing a defense given by an Illinois utility in an attempt to justify cooking and instantaneous water-heating rates on the ground of general increase in load factor, decided and ordered reconsideration of the company's formal power rates from the same standpoint, and pointed out to that utility, as I have just attempted to show, that the necessary investment to serve was the primary index in classification of load characteristics and resultant load factor, and not the nature of the service to which it was applied. Therefore, it is most necessary that each central station, during the period when it is formulating its cooking and water-heating rates, merchandising and sales policies, should consider the absolute necessity of exploiting to its prospective amplified domestic consumers only those cooking and, particularly, water-heating devices whose resultant load characteristics impose the minimum service demand and thereby require a minimum additional invesment in terms of the increased revenue which will result from the amplified domestic service.

The last question—how can we handle our water-heating —necessitates a double answer, because at the present time, although there is a decided trend in the direction of placing water-heating on a meter rate, a great number of companies are still exploiting water-heating by offering the consumer a flat monthly rate for a certain service.

A word with respect to the flat rate: Its application usually means the installation of a double-throw switch between range and water-heater, which makes it non-automatic in operation, and, together with all the difficulties incident to over-heating and under-heating, as your committee on water-heating points out, the most vital factor is that it imposes upon the housewife such added responsibilities of operation that the service is not worth the amount of money which the central station should earn from the exploitation of hot-water service. That is, from the standpoint of available revenue, the flat-rate does not, by virtue of the nature of the non-automatic apparatus which is usually exploited under it, give the valuable service which the consumer is willing to pay for if granted automatic equipment on a meter rate without the incumbrance of a double-throw switch.

From the standpoint of kilowatt-hour consumption, the flat rate induces no economy on the part of the consumer, and hence is economically wrong. The one undeniable advantage of the flat rate, however, lies in the fact that it offers a means of easy introduction, since the quotation of a flat rate, in terms of so many dollars per month, overcomes the high-cost-of-operation-fear inherent with the consumer at the mention of a continuously operated electrical device.

The second means of handling water-heating, namely, exploitation on a meter rate basis, induces maximum economy on the part of the consumer and is therefore the only economically-sound basis upon which electric water-heating can expect to find a permanent application.

The first point, however, in placing water-heating on a meter basis, is to accept the fact that, regardless of the type of apparatus or method of introduction, electric water-heating must be granted a low unit rate—1c to 1½c per kw.-hr., in order to make it economically practicable to the consumer in terms of competing fuel costs.

Immediately following this conclusion, in line with the points which I have tried to bring out, comes the conclusion that if electric water-heating, in order to be universally practical, must be granted a low unit rate per kw.-hr., then we must exploit that type of water-heating apparatus whose operation in terms of load characteristics and necessary station investment will earn for it, that is, entitle it to, the low unit rate of 1c to 1½c per kw.-hr. when compared to the load characteristics, etc., of other small power devices, motors, rectifiers, etc., the service demands of which, as has been pointed out before, do not earn the low rate required by electric water-heating. Hence the conclusion as to the method of handling water-heating would be—the exploitation of that type of water-heater so automatically controlled as to produce load characteristics which earn the low unit rate per kw.-hr. which will enable the meter application and the elimination of the flat rate, and at the same time earn for the company, by virtue of the value of the automatic service granted to the consumer, that revenue—$3.00 to $5.00 per month—which so many stations are now earning from water-heating consumption.

The last point to which I wish to ask your attention is the advisability of developing a rate of such form, or including a provision, to make practicable the operation of low-capacity automatic water-heaters even if an electric range has not been sold.

You will note that the first rate in the above-suggested form will enable the economic operation of an automatic water heater installed in connection with only the lighting requirements, which total connected load would not exceed 7½ kw. In my experience, the water-heater offering automatic hot-water service has always proven an effective salesman for the range. Everyone knows what hot water is, and further, appreciates the value of automatic hot-water service. No missionary work is required in introducing the automatic water-heater which can be operated on an economical basis, whereas electric cooking, being less tangible as between salesman and consumer, many times defers the sale of both the range and water-heater.

Given the ability to introduce electric cooking through the medium of automatic hot-water service, and given water-heating apparatus which is so automatically controlled that it requires no additional transformer, copper and meter investment, and finally, given a rate with the high cooking block eliminated until the range is sold, the condition is then ideal for the production of maximum revenue from the minimum investment and the least sales effort and expense.

The power man may assist the farmer in production of agricultural products by joining in the "swat-the-rat" campaign. Some idea of the expense connected with the maintenance of rats may be learned from the fact that a full grown rat consumes about two ounces of grain daily, from forty-five to fifty pounds a year. At the present price of wheat, it would cost a warehouse man several dollars annually for the maintenance of each rat upon his premises. Since other food supplies are now proportionately high, the expense of rat maintenance to the average householder may be just as great.

ELECTRIC COOKING AND WATER HEATING

(Electric cooking and water heating are subjects of tremendous import in the West where available hydroelectric energies are daily extending the application of electricity to every detail of the modern home in the West. Here is a discussion participated in by practically every well-known man of the electrical industry in the West interested in this phase of electrical development. The following pages are the stenographic reports of the discussion on this important subject in the commercial section of the Pacific Coast Section N.E.L.A. convention at Riverside, April 19-21, 1917.—The Editor.)

S. V. Walton: We have two more subjects on our program for this afternoon, and we will now have to stop the discussion on rates. The next subject is electric cooking and water heating. In the absence of Mr. Black of the Great Western Power Company who was delegated to handle this subject and who abstracted the report, I will refer to the printed report in the Journal of Electrcity of April 15th and April 1st which contain the report of the water-heating committee, giving results of laboratory tests. In justice to the Northwest Electric Light & Power Association I want to say that the water-heating report was started by the Northwest Association a little over two years ago. The tests were made in a laboratory of our company, supplemented by other tests, some by the Great Western Power Company, particularly, and, as far as I know, constitute the first and best authentic records of such tests. The cooking and water-heating subjects go together. Electric cooking by itself is incomplete. Our records show, and I think the records of any other company that has taken the trouble to get records will show, that the water heating load in addition to the range load more than doubles the business without increasing the demand on the central station, providing proper equipment is installed. Our records show on a large number of installations that the return per month per consumer of ranges alone was about 103 kilowatt hours. For water heating alone it was about the same. That the two together would more than double the two added together and treated separately, for the reason that where the water heater is installed with the range it makes a complete electric kitchen, and the use of the equipment is carried out more than where only one is installed and other apparatus, either coal, wood or gas, left in the kitchen to fall back on. The subject of rates is intimately tied up with the subject of cooking and particularly water-heating. I question whether we can get very far on the water-heating subject unless lower rates are made, either flat rates or very low meter rates.

I think it better to have a full discussion on those various questions from the floor rather than too much from the chairman. You all have the report to read. Is Mr. Childs, of the Southern California Edison Company, in the room?

A. W. Childs: The question of electric cooking and water heating has been interesting the companies of Southern California for the past year, and our company is maintaining an organization especially for the promotion of the use of electrical energy for these purposes. We have found it advisable to adopt a rate by schedule which the householder can take the energy for lighting, cooking and water heating through one meter. We have started with an initial rate of 7 cents, our regular lighting rate, divided the dwellings into three classes according to the number of rooms, houses of five rooms or less taking the first twenty kilowatt hours per month at the 7-cent rate, six or seven room dwellings the first thirty kilowatt hours, and residences having in excess of eight rooms the first forty kilowatt hours at 7 cents. For the next 100 kilowatt hours where an electric range is installed and used, a rate of 3½ cents per kilowatt hour is given and if a water heater is installed, after the block of 100 kilowatt hours at 3½ cents a rate of 2 cents is applied. We have at the present time installed or contracted to install 1450 ranges. We started the range promotion sometime prior to the promotion of the electric water heater, but the electric water heater is taking very favorably. We now have in the neighborhood of 100 installed and in satisfactory operation. The range as it is manufactured and sold today we find to be quite a satisfactory product. It is filling the bill. The water heater has been brought forward very rapidly and it also is filling the bill. We find quite a sale for the automatic water heater which allows hot water to be on tap during the 24 hours, and quite a demand also for the non-automatic water heater, both of the boiler type. I don't know just what phase of this subject to emphasize in starting the discussion. The load is attractive. The want is apparent, and is felt especially amongst the rural consumers. We believe that the elertric cooking and water heating load offers one of the best opportunities before the central station today.

Chairman: There is one phase of the subject that I meant to touch on but did not think of it until Mr. Childs mentioned the word "felt." It seems to me the problem in the water-heating game, in addition to the rate, is one of insulation I am going to ask Mr. Newbert of the Pacfic Gas & Electric Company to discuss the subject.

L. H. Newbert: In discussing this matter I will only tell you in a brief way of our work. We believe that it is a subject that we have yet to learn a great deal about. Therefore we are proceeding rather conservatively. What we are doing we are endeavoring to do well. By that I mean we are not endeavoring to place the greatest possible number of electric ranges and water heaters, but we are endeavoring to sell the ones that we do sell in a manner that will result in their staying on the line. A failure in a small place is generally known by all in the community and the injury done is hard to undo.

We are limiting the work almost wholly to what we call our suburban territory. We have a small organization consisting of a chief salesman, a head demonstrator, and several salesman. We hold demonstrations in the different centers of population. These last from two to three, four or five days, depending on the size of the place. These demonstrations are advertised as electric cooking schools. The prospects developed at these schools are followed up by salesmen. We confine our attention to people or consumers who we believe can afford to use the electric range, because we don't claim that electricity is the most economical of fuels. We believe that it has advantages which justify paying a little higher price for the service. We endeavor to displace entirely other means of cooking, and aim to secure complete electric kitchens.

While our number of installations is rather small, we have a very high percentage of water heaters. Our range connections last year were 335, and of that number 165 had water heaters installed. That means that we have about 165 all-electric kitchens.

Our company is selling ranges at manufacturer's list price, allowing 10 per cent down and the balance in 12 equal monthly installments. The cost of installation up to $50 is borne by the company. Any amount over $50 is charged to the consumer.

The work of installing is let out to local electrical contractors. Ths has worked out generally satisfactorily. Not always, however, because in some districts we have had difficulty in getting a contractor to do the work promptly, and when it is not done promptly dissatisfaction results. In other words, the consumer is disappointed and dissatisfaction follows.

After the range is installed the demonstrator calls and gives very thorough instructions. The call is followed up by as many future visits as may be necessary in order to thoroughly instruct the operator.

We have found that where hired help is in the kitchen we have our difficulties. On the other hand, even at our rate, which all our consumers think high, we have found the operating cost reasonable where the work is done by the housewife.

The average bills for range and water heater consumers last year was $6.85. The water heater alone, $3.85. The range alone, $3.65. Where we are able to place a water heater with the range we just about double our revenue without any additional investment. All our installations are made with a double-throw switch. In other words, the water heater is not in service and cannot be used when the range is in service. Therefore when we are able to place a water heater we double our revenue without any additional expense whatever.

We do not confine our sales to any one make of ranges. We sell all that we think will give satisfactory service, so as to distribute our business amongst the various jobbers. The ranges all give satisfactory results. We, of course, have some difficulty with elements burning out. However, in this respect we have the heartiest co-operation from the manufacturers and jobbers and, I think, our consumers are generally satisfied with the service that we are giving in maintaining the ranges.

There is no question but what the electric range has a big future. Anyone who sits back and pooh-poohs that idea will find out that he is mistaken. The water heater problem has not yet, of course, been solved, and I believe will be solved only by making special low rates on small heaters operated over rather long periods, rather than heaters of large capacity, operating for short periods.

Chairman: Mr. Newbert, Mr. Whaley wants to ask you what rate you find will produce a satisfactory monthly revenue?

L. H. Newbert: Our schedule is as follows:

Schedule No. 152.—Electric Cooking, Heating and Power Rate

Based on the monthly consumption per meter

4. cents per kilowatt-hour for the first 30 kilowatt-hours per kilowatt of active connected load.
2. cents per kilowatt-hour for the next 90 kilowatt-hours per kilowatt of active connected load.
1.5 cents per kilowatt hour for all over 120 kilowatt-hours per kilowatt of active connected load.

Minimum Charge

Contract.—Where consumer signs a contract agreeing to take service for at least 12 consecutive months the minimum charge will be $24.00 for each 12 months' period for the first 5 kilowatts or less of active connected load, and $12.00 per kilowatt for each kilowatt of active connected load in excess of 5 kilowatts. Minimum due and payable monthly.

Non-Contract.—Where consumer does not sign a contract for at least 12 consecutive months the minimum charge will be $2.00 per month for the first 5 kilowatts or less of the active connected load and $1.00 per kilowatt for each kilowatt of active connected load in excess of 5 kilowatts.

Active Connected Load

The active connected cooking, heating and power load shall be taken as 100 per cent of the first 2 kilowatts installed and 50 per cent of the connected load installed in excess of 2 kilowatts, computed to the nearest one-tenth of a kilowatt, but is never to be taken as less than 2 kilowatts. Motors and instantaneous water heaters will be rated as 100 per cent active connected load. Motors aggregating not more than 5 horsepower, and not in excess of the total connected load of heating and cooking appliances, may be included on this rate and will be rated at 1 kilowatt for each horsepower of output rating. Where the connected load is so arranged that all of it cannot be connected at one time, only the maximum load that can be connected will be used as a basis for the active load. All equipment will be assumed as operating at 100 per cent power factor.

Installation

The consumer's wiring for electric cooking, heating and power service must be separate and distinct from that supplying other service, and no lighting installation will be permitted under this service, except indicating or pilot lights used in connection with heating and cooking appliances.

A suitable meter board must be provided with service switch and cutouts. The cutouts or fuse blocks must be installed in a metal box, which may be sealed by the company, the cutout box to be located ahead of the meter.

When the active connected load does not exceed 2 kilowatts, service will be supplied at 2-wire 110-volts. When the active connected load is in excess of 2 kilowatts, service will be supplied at 3-wire 220-volts or 2-wire 220-volts. When 3-wire 220-volts service is supplied the consumer's circuits must be connected on each side of the neutral conductor so that the actual unbalance of the load on the 3-wire system should at no time exceed 1800 watts.

When motors are used under this schedule the service conditions for same must conform with the rules for power service.

Territory

This rate applies in all territory except in the cities of San Francisco and Sacramento.

E. B. Criddle: What average rate per kilowatt hour does that make for the consumer?

L. H. Newbert: About .029 per kw.-hr.

A. G. Wishon: What load factor?

L. H. Newbert: We have really as yet no reliable information on that point. We are now preparing to get the information, and also the diversity factor, so far as we can, with the limited number of installations we have. The information will be available within the next three months.

H. S. Batchelder: I would like to ask Mr. Newbert and Mr. Kennedy what provisions they are making to make the combination perfect electric kitchen. We cannot call a kitchen electrically equipped which in our climate is not equipped at certain times of the year to take care of the heating question. A kitchen which has an auxiliary burner, either for the disposition of garbage or a gas or coal oil stove, is not an electric kitchen. I would like to ask those gentlemen what method they are pursuing toward making the kitchen an electric kitchen throughout under those conditions.

L. H. Newbert: From that viewpoint we have no complete electric kitchen, because we have made no attempt to heat the kitchen with electricity. We have many consumers who do not require heat in the kitchen. They have heat in the dining room which is communicated to the kitchen. Where the consumer does want heat in the kitchen we have recommended an inexpensive type of air-tight stove which can be purchased for four or five dollars.

H. S. Batchelder: Why is that done? Are we not trying to establish a diversity factor which will take care of the current we have to sell? Isn't there some method that can be devised whereby the heating can be maintained electrically in the kitchen instead of pursuing roundabout methods to avoid the question?

L. H. Newbert: I cannot answer the last part of your question. At our rates at the present time we do not believe it would be fair to recommend to the consumer the heating of their kitchens with electricity.

Chairman: I have discussed that very question with Mr. Coldwell of the Northwest Association. They have a condition of more extreme cold than we have, and some of the companies, particularly at Spokane, have given a great deal of thought to that problem.

O. B. Coldwell: I cannot say that that problem has been solved in Spokane any more than here. The question of air heating in large cubical contents is something that possibly we are hardly up to as yet. In that connection I have in mind a pamphlet which was put out by the Oregon Hydro-electric Commission only recently going into the relative heating values of the various kinds of fuels used in household heating, and there are some very startling figures given. I cannot recall them at the moment except in one or two cases where with wood at something like $5 a cord and electricity at one-half a cent a kilowatt hour, you have a disparity of something like ten to one in the matter of cost. In other words, it is discouraging to find that solution just at the present moment. Personally it seems to me that the investment factor that is involved in carrying out general house heating would be almost prohibitive at the present time. But that is getting off on the point you are making which is merely that of the kitchen in the case of Spokane which was mentioned by Mr. Walton. I believe they have solved it as some of the member companies here have by means of the briquet heater or small gas heater or combined refuse burner. I cannot assure you that we have solved the question in the Northwest any more than you have here.

H. S. Batchelder: What I would like to know is this: There are certainly on the market electric heaters of sufficient capacity to heat an ordinary kitchen. Why not sell them? We have the electricity to run them and they can

be run economically provided the conditions are right. You admit that the majority of the business is obtained in suburban districts. Under those conditions in these districts, owing to the H. C. L., wood, coal, and gasoline have gone up, and it seems to me that we could compete with those articles. Have you, Mr. Newbert, or have your salesmen asked out in the suburban districts how much their average monthly fuel bill was, and received a reply that was approximately correct?

Chairman: I would like to ask you the same question.

H. S. Batchelder: There is a thing I wanted somebody with some experience to tell me. Why can't we sell an electric kitchen complete? I have an idea for a solution. In the past 55 days we have placed 19 electric ranges, 15 water heaters and 11 air heaters. There were no air heaters sold in the past two weeks because we had warm weather. We find in every instance where we sell a range that we can sell a water heater where it is properly introduced. The only reason we have not sold those four was on account of the erection of new houses. In those instances I have found that in most cases they knew fairly well what they were burning, because they have carted the wood and the coal and the coal oil to their ranches, and I have made them approximate what that cost was per annum, and on our rate have shown them what it was for heating it electrically. That is, I have taken a certain type of radiant heater, and by experimenting myself and with a few of the consumers, we have found that we can heat the average kitchen in comparison with an ordinary stove or auxiliary heater as cheaply on a 1½ cent rate as they could with any other method. I don't mean to keep an electric kitchen heater averaging 1800 watts going ten hours a day, but heating it comfortably by operating a doublethrow- switch, said heater having 3 switches, 1, 2 and 3 heats.

S. M. Kennedy: The question, Why not an electric kitchen, is a very pertinent one and it is not at all an impossible condition. Mr. Coldwell who comes from a cold country, and some of the other Northern people who do not live in the glorious climate of Southern California, have different conditions from what we have. In the south we believe we are about to solve the question, and when the consumer wants electricity in the kitchen he can have it for everything. We believe that with the cooking rate at 3 cents a kw. hr. for the first 100 kw.-hrs. after taking an average amount for the lighting requirements and the balance at 2 cents, that we have to a large extent got the water heating question solved, and we have also the question of taking care of the heating of a kitchen in the winter time. We have filed a schedule of the character that I have spoken of that is very easy to understand. When the range is on the water heater is off. Consequently, if that schedule were effectual, the room heater would be off at the same time.

But we propose to mutilate that schedule. We are going to make it so that they can use the range and the water heater at the same time, and if they want to use a room heater they can do it also. Now, why have we changed? We find this idea of the water heater piling up your peak is a bugaboo. It doesn't do it. Consequently, you can leave the water heater on at the same time and eliminate the double-throw switch, and this helps to build up your cooking load. The average kitchen is not a big room, and in the winter time in this glorious climate of Southern California, the amount of heat required is not a great deal.

Why talk of any other means than electricity for heating? We have the electricity to sell. We have the installations. We have the transformers and the meters. For goodness sake, why do they want to bring in anything else to heat the kitchen, especially in Southern California?

Let me point to another phase. Mr. Coldwell has spoken of wood at $5 being about equivalent to electric heat at one-half cent per kilowatt. How much of that wood heat goes up the chimney? How much of the heat efficiency is there that you do not get in the kitchen? How much of the electricity do you use when you put it into some kind of a heater? You get 100 per cent efficiency. If you are going to look at the heat units in wood or coal or any other fuel and compare them with heat units in the kilowatt hour that stays in the room in a good clean way, there is no chance of doing business. But if you give the electricity the credit that is due to it and you put it on at a rate as low as 2 cents per kilowatt hour after you have supplied the lighting and the cooking, you are going to get the electrical kitchen which we all want.

John A. Britton: Any gentleman here who desires to be educated thoroughly and fully upon the question of the efficiency of British thermal units, let him attend the gas association's convention to be held in Northern California in September.

H. F. Jackson: I would like to say a word. I have had just the experience Mr. Batchelder referred to. We decided a year ago that this idea of double meters, double throw-switches and four or five other things, was a big bugaboo. We have had experimental rates in effect about a year. Anything in a domestic installation we put on the one meter. The first 25 kilowatt-hours at 10 cents, the next 100 at 3 cents, and all over that for any purpose, 1.1 cent, with 10 per cent discount for prompt payment. We think it is solving the question. We don't think we are suffering. As I say, it is an experimental rate, and in the meantime we are popularizing the house electrical and we have several consumers in the San Joaquin Valley who are enthusiastic over this rate. I am talking for one meter, one service, and a block rate that will take care of the different kinds of use.

Chairman: Mr. Britton calls my attention to the fact that Capt. Jackson is not an electric light man but a philanthropist.

Glenn D. Smith: I would like to talk more particularly to the managers of the small companies on the matter of electric cooking. Being the manager of a small company (Ontario Power Company), it is possible that you will be interested in our experience along this line.

We started last June with demonstrations in the two principal cities where we operate, Ontario and Upland. We ran demonstrations in these two cities simultaneously for thirty days, demonstrating the ranges, serving people with lunches, and carrying on a campaign of advertising and education.

After closing the demonstrations, we put out solicitors and also established an electric kitchen in our office building and created a range service department in charge of a young lady demonstrator. This young lady not only has charge of the range sales at the office, but gives demonstrations in our electric kitchen and also makes voluntary calls upon the users of our ranges to assist them in any way she can and particularly in working out the proper economy. Since last June we have installed approximately 140 ranges, being about one to every 17 of our residence customers.

Prior to our demonstration, we had 123 customers who were cooking with the separate ovens and the old-time individual stoves. Some of these have changed over to ranges. We have now about 250 who are cooking exclusively with our current. Our rate is for the first 20 kw.-hr. per month, 9c, the next 130, 3c, and all over that, 2c, with a 10 per cent discount for prompt payment. We have had very little complaint. The users of the ranges are pleased with them and are using them economically. I recently took a list including the first 92 of our cooking accounts and the average bill was $5.08 and the average consumption, 140 kw.-hr. per month.

We permit on our cooking rate, the use of current for any domestic service. They can charge their electric automobiles, grind chicken feed, or use the current for any purpose they wish; however, very few use it for any purpose except cooking, heating and lighting.

As to heating the kitchen, many of our people are heating their kitchens electrically. The current used for this purpose

would come on the 2c rate, and those who are using it seem well pleased with the service and the cost. We are heating one house exclusively with electric heaters. We installed the heaters in this house more as an experiment than anything else. They have been using it practically all winter and consider it the most satisfactory heating they have ever had, it being flexible, clean and convenient, and the experiment with this house seems to indicate that a rate of about 1.2c per kw.-hr. would compete with coal.

The average small company has but small opportunity to increase its industrial power load and I believe the residence field is the one that should be strongly developed and I believe that the electric range offers the opportunity for this development and that any small company that will take it up and not be afraid of it and will push it, can do as well as the Ontario Power Co. I have analyzed very closely the past three years the returns from business on our cooking rate and I find, and I think I can defend this, that one cooking customer is as good as five lighting customers in the annual net returns of the company. You may not be able to make the same rates as we have as that would depend upon your generating and distributing costs, but, I believe that the small company has to look to the electric cooking for its largest increase in business and that it is their most promising field.

Chairman: I have to hand it to these Southern California fellows for the way they hang together on the climate business. Will you come forward, Mr. Kimball of Oakland? We want to look you over.

Hugh W. Kimball: I would like to say a word on the subject from the standpoint of a contractor-dealer. Mr. Jackson made a point pertaining to the selling of electric current both for light and power on one meter, having a minimum first charge at the regular rate current is sold for lighting purposes covering the maximum consumption of current used in the average home for such purposes, and then resorting to the power rate as determined by the various companies for the balance of the load. This point has appealed to me from a standpoint that has not been touched on, and that is, the economical simplicity of installation. You must realize that it would be much easier for the power companies and for the consumer and for the electrical contractor and all concerned to make it possible to consume this current under one meter reading than under two.

In the first place, the expense of wiring installation would be materially decreased. The Underwriters' rules must be conformed with and it often occurs, in preparing a house for an additional meter, that we have to install an entire new service due to the rules pertaining to the installation of two meters, whereas in reality the present feeds are adequate as far as manner of installation and current consumption is concerned. Furthermore buildings already constructed have been prepared for a meter space or box of sufficient size for one meter and the electrical contractor often finds it necessary to tear this box out, cut a larger opening in the building which must be finished in workmanlike manner and a new cabinet installed of adequate size to allow two meters and the necessary additional cutouts, switches, etc., for same. This, of course, is of considerable expense to the owner, very often to such an extent that it is prohibitive. The idea of installation of heating devices is often abandoned on this account.

Secondly, the furnishing of current for both purposes under one meter instead of two would save the expense of one meter on each installation for the power company.

In the third place we have found that a big obstacle in the way of placing electrical heating devices in the home is, that in making the installation with a varied rate on two meters we have to explain to the consumer, and it is hard to explain to them because they do not understand all the intricate details pertaining to the installation and the expense thereof, and they very often become confused and give up the idea for the simple reason that they do not understand it. The public take a great deal on faith as it is but it is next to impossible to get a man to part with his money when he does not understand just what he is getting in exchange, and what the ultimate outcome of the whole transaction might be.

If the power company could sell this current to the consumer under one meter reading for both purposes these obstacles could be reduced to the minimum.

Another point that has not been touched on to a great extent is, the proper education of the public of the use of electrical heating and cooking devices. I listened to Mr. Batchelder's remarks in regard to the placing of air heaters in the kitchens where electric ranges are used, for the purpose of warming the room and his question as to their practicability. My firm put on the market last year, as they have for several years, a large quantity of air heaters, varying in size from 500 to 1800 watts. Most of these have gone to the consumers who were paying for their current on the seven cent rate. In selling the heaters we have been careful to explain to the consumers just how long they could burn the heater for their seven cents, or just what they were paying for an hour's consumption. I am positive from records that have been kept in my place of business that out of approximately 150 which were sold during the last winter season we only had one complaint from the stand-point of the consumption of current and practically no complaints from other reasons. Now, if we can install these heaters on a cheaper rate in conjunction with electric ranges, water heaters, and other current consuming devices, or on the same meter measuring the lighting consumption load on a varied rate as previously explained, I am positive there would be no complaint of any nature, and that we could place a far greater number of heating devices in the homes.

The education of the public to the proper use of heaters also holds true in regard to the sale of electric ranges. I know of one installation in the northern part of California where a large apartment house was equipped by the owner for the use of electric ranges. That seems to me to be a thing that all electrical men should discourage for this reason; that if consumers do not know how to handle the range and what the range will do, it is not going to be economical. I talked to the owner of this building and he told me that he was forced to remove the electric ranges in this apartment house, due to the fact that they were not satisfactory from a current consumption standpoint. The electric range was a big drawing card in obtaining new tenants; the young housewife going into the apartment would, of course, start using this range when she would not have any knowledge whatsoever of the consumption of current and its use, nor the proper method of obtaining the highest efficiency from the current consumed, with the result that half of his house was without tenants most of the time, due to the fact that after the first month's bill arrived for current the tenants were discouraged by the enormous cost and could not be persuaded to continue. A thing of this kind is extremely detrimental to the perfection of the sale campaign we are putting on to carry this product to the market. I believe the power company should instruct their solicitors to be cautious in making claims to the public of the current consumed by various devices and particularly in the instruction to the public of the proper use of such devices.

I have in mind a case where we installed a certain type of range in conjunction with a water heater and an air heater for one housewife, who found it very satisfactory and economical. We made an identical installation for another consumer, with the exception that we furnished an additional oven. I was not anxious to make this sale for the reason that she had a colored cook in her kitchen and I found she paid little attention to household matters. The latter installation eventually proved unsatisfactory to the purchaser and naturally was not of any credit to the industry. The first

installation was handled at an average of from $5 to $6 per month, while the latter averaged to from $30 to $40. The colored cook used this range at all times and I think he tried to heat the kitchen with the range which, of course, was impossible. That is ultimately going to hurt all the way down the line, as will every unsatisfactory installation. The news of a poor installation will travel a great deal more rapidly and take deeper root with those who bear it, than woud a half dozen satisfactory installations.

There are many ways in which the electrical contractor and dealer can co-operate with the central station men in the proper placing of this product on the market. There is one point I might touch on in closing, and that is the manner of installation. In our district we have paid particular attention to the installation of ranges and the necessary wiring and equipment for same. It has only been a short time since we had a committee of the inspection force of the city hall at our store for the purpose of going over the proper manner of wiring for and installing electric ranges, with a view of lessening the cost of the installation to the consumer. The rules of the Underwriters pertaining to the installation of electric ranges is that portion of the rule pertaining to the installation for power equipment and in many instances is far more drastic and expensive than is necessary for the installation of ranges. If the central station companies throughcut the State will work in harmony and in conjunction with the electrical contractors and dealers in obtaining from the various inspection departments, special rules pertaining to the installation of ranges the expense pertaining thereto each could be greatly minimized which will greatly assist in bringing their product and our product to the market.

Chairman: We are very glad to have had Mr. Kimball speak on this subject. I don't know of any one in the dealer and contractor class, as we know them in the vicinity where I come from, who is better qualified to speak on the subject than Mr. Kimball, both from the dealer and from the contractor point of view.

W. S. Leffler: Mr. Black has properly said in his paper on electric water heating that, although there seems a decided trend in favor of the step-thermally controlled automatic water-heater, yet the field of hot-water-service exploitation is still characterized by a wide divergence of opinion..

I wish to discuss revenues, comparative net revenues, comparative sales effort, and comparative value of the service rendered the consumer by the different types. Or, in other words, how much is the best kind of hot-water service worth to the consumer, and what will the net revenue to the central station be, when fixed charges on the station's investment (equipment and sales cost) are deducted from the gross revenue available from that type of apparatus which renders the most valuable service to the consumer.

As our specific examples, let us take, on the one hand, the 5 kw. instantaneous-demand non-automatic, manually-operated, circulation type of tank heater, and our second example—directly opposite in every characteristic—the 1.5 kw.—250 watt graduated-step-demand, automatic, thermally-controlled immersion storage heater.

First, let us consider the water-heater as isolated from the range, both from a revenue and investment-to-serve standpoint. That is, altho it has been shown that the water-heater, properly handled, doubles or triples the range revenue without increasing the investment, the point I wish to make is that we cannot charge all the domestic service investment onto the range after the water-heater is installed, but instead should charge against the water-heater its pro rata of the total investment made to serve the combined range and water-heater.

Returning, then to the two widely different types of heaters, and taking first the 5 kw. instantaneous, non-automatic, circulation equipment:

Consider first the value of the service rendered. It is at once evident that the non-automatic type of heater is hardly more than a poor substitute for a non-automatic coil gas heater. It is not much more trouble to strike a match than it is to turn a switch, and further, since the average 25 ft. coil gas heater has about twice the speed of a 5 kw. circulation electric heater, it is at once apparent that, in exploiting this type of equipment, we are merely offering the consumer a service which, with all factors considered, is at best little better than a poor emulation of the small non-automatic gas-heater service. Since the small gas heater gives this service for about $2.00 per month, it is economically unsound to think that this same service electrically rendered would bring more than $2.50 per month, for, as Mr. Britton has just said, the consumer's mind is found to travel back to gas service.

As to actual kw.-hr. consumption, it is further evident that, due to the necessary wait of 15 minutes or so to secure water in practical amounts, the consumer would use much less hot water and hence we would expect the high capacity non-automatic type of heater to reduce our available water-heating revenue by from 75 to 100 kw.-hr. per month, which therefore almost automatically limits the revenue, with energy at 1c to 1½c per kw.-hr., to about $2.50 per month, or approximately $30.00 per year—gross revenue from 5 kw. instantaneous demand. Now if our domestic feeder, transformer and pole-to-house investment aggregates even a minimum of $20.00 per kw. of domestic load connected (forgetting for the moment the possible necessity of hanging a special transformer for the installation), then for a 5 kw. heater we have a fixed feeder investment of $100.00, with annual interest, maintenance and depreciation charges of 15 per cent, amounting to $15.00 per annum, which when deducted from the gross available revenue from this type of apparatus, namely, $30.00, leaves only $15.00 net annual revenue from 5 kw. of demand, or $3.00 per kw. per annum, together with the fact that, since we are merely emulating non-automatic gas service, we cannot possibly expect to derive a larger revenue than that above indicated.

Turning now to the consideration of the heater of opposite characteristics, namely, the step thermally-controlled type of heater referred to in the report of your committee, we have:

First, with respect to the value of the service. Instead of non-automatic, intermittent electrified gas-service, we are now able to offer the consumer automatic instantaneous, continuous hot-water service available to every tap in his house, at the scalding-point temperature (far above gas temperatures if he so desires it). Hot water in any quantity to suit his needs, whether he have a two-room bungalow or a 200-room hotel. Perfect service—automatic service—no repairs, and the complete elimination of all flame and gases and the menace incidental to operation of a fuel heater. As to the value of the service, most certainly this service is worth the dollar or so more than the $2.50 per month at which we have just been evaluating the non-automatic, intermittent, gas-emulated service.

The experience of a half-dozen coast companies show that this automatic service, by virtue of its value, really sells for from $4.00 to $6.00—which the 200 to 400 kw.-hr. per month consumption earns under the prevailing Coast rates. So, as to the value of the service. Even figured against the automatic gas-heater bills, the service, including the frequent repairs and gas copper coil replacements, is well worth $60.00 per year. Properly applied sales intelligence will readily sell this service for $50.00, which this type of water-heater will earn at 1½c per kw.-hr.—or $40.00 per year gross at 1c per kw.-hr.; $40.00 per year minimum gross revenue, because the automatic service is worth $40.00—assuming, of course, as Mr. Kennedy has just said, we are using that type of apparatus which obviates all necessity of the double-throw switch due to the automatic action of the step thermal control developing such load characteristics as keep the water-heating load

(Concluded on page 449)

PACIFIC COAST SECTION N. E. L. A. JOTTINGS

(Activities of the Pacific Coast Section, N. E. L. A., during the past semi-monthly period, have largely been in the nature of outlining suggestions to the state and federal authorities concerning definite service that central stations of the West are prepared to render to the national government during the present crisis. Other undertakings of this organization, of interest to engineers of the West, are reflected in the minutes of the executive committee meeting of May 25, 1917, details of which are set forth in the following lines.—The Editor.)

MINUTES OF EXECUTIVE COMMITTEE MEETING MAY 25, 1917

The meeting of the executive committee of the Pacific Coast Section National Electric Light Associa- was called to order at 10:15 at the office of the president, No. 58 Sutter street, San Francisco, May 25, 1917.

Present: President Jackson, Vice-president Samuel Kahn, Secretary A. H. Halloran, Henry Bostwick, W. W. Briggs, D. E. Harris, H. C. Reid, K. E. Van Kuran,

President Jackson announced the appointment of S. V. Walton as chairman of the commercial committee, J. E. Woodbridge as chairman of the Engineering Committee, C. P. Staal as chairman of the Accounting Committee, and W. L. Frost as chairman of the Membership Committee. The chairman of the several committees will decide upon the personnel at a later date. He also outlined Mr. Van Kuran's suggestion that subcommittees be appointed at Los Angeles, Reno, Phoenix and Albuquerque to make suggestions to the general committees, through their local representative on said committee.

John A. Britton of San Francisco, W. A. Brackenridge of Los Angeles, A. G. Wishon of Fresno, George Campbell of Reno, M. R. Buchanan of Silver City and Frank Russell of Tucson were selected as members of the Public Policy Committee.

President Jackson announced that the Committee on Petroleum of the State Council of Defense had requested the association to offer suggestions as to how a further saving could be made in the use of fuel oil. He told of a meeting with Mr. Max Thelen, chairman of the committee, in which he had outlined four suggestions which upon receipt of further data from member companies will be incorporated as a part of the committee's report to the council. These suggestions include (1) the inter-connection of all transmission lines so that any deficit of hydroelectric power on one system may be purchased from another system having a surplus without the necessity of starting up steam reserve plants; (2) that representations be made at Washington to induce the government to change its policy regarding the development of public lands so that more hydroelectric power may be available; (3) that the railroads be electrified so as to reduce the consumption of fuel oil in locomotives; and (4)that some definite policy of extensions be adopted so that electric motors may be substituted for gas engines and isolated plant service with some scheme of protection from the Railroad Commission to provide against taking of unprofitable business.

K. E. Van Kuran stated that the proposed taking over of distribution lines at Los Angeles by the city would complicate the plans for joint merchandising action between the central stations and contractor-dealers. He was finally advised to take up the matter individually with the Los Angeles interests concerned.

Henry Bostwick introduced the following resolution to be sent to the several state councils for defense represented in this section:

"Resolved, That the Pacific Coast Section of the National Electric Light Association, through its secretary, address the secretary of the State Council of Defense, tendering to the council the active support of the section as well as of the individual members of the association.

"This association having associated with it practically all the electric power companies of the state, it is felt that such co-operation can be of great value to the council in the matter in hand."

On motion duly made and seconded this was adopted.

The appointment of S. J. Lisberger as representative of the section on the committee for the revision of the San Francisco Electrical Ordinance was approved.

Meeting of the Commercial Section Committee

A meeting of the commercial section was called by Chairman S. V. Walton at San Francisco on May 25th, with J. B. Black, H. A. Lemmon, A. E. Holloway, R. M. Alvord, Miles F. Steel, W. S. Berry and M. L. Scobey of the committee present, and E. B. Walthal, H. C. Aller, C M Einhart, A. W. Childs and E. B. Criddle absent. The meeting was also attended by G. F. Wakeman, Frank Somers, Jas. W. Redpath, Ed. Whaley, L. H. Newbert and C. F. Butte.

It was decided that sub-committees be appointed by the general committee member in each locality to represent the various electrical interests so that their recommendations may receive action by the general committee. The following schedule of work was outlined as the year's program.

(1) Study of merchandising conditions arranging for co-operative selling plans between central station and contractor-dealers on lamps, ranges, appliances and motors.

(2) An investigation on electric cooking and water heating.

(3) Study of industrial electric heating.

(4) Report on illumination, outside and inside.

(5) Investigation of electrical vehicle situation.

(6) Report on refrigeration.

These several subjects handled by sub-committees and will form the basis of reports to be presented at the convention.

It was decided there should be four meetings of the Commercial Committee during the year to be supplemented by frequent meetings of local sub-committees.

SUGGESTIONS FOR CONTRACTOR AND DEALER

DEPARTMENT CONDUCTED BY GEORGE A SCHNEIDER

(The starting of motors by what is known as the "star-delta" method is a matter of much importance to the contractor and dealer. This article completes the discussion on this subject which was begun in the issue of February 1, 1917. The explanation of the methods of selecting fuses for motors stated in this manner is exceptionally complete and is shown in an original way. It should serve to clear up much misunderstanding on this subject. The author is power apparatus specialist for a well-known electrical supply house in San Francisco.—The Editor.)

STAR-DELTA METHOD OF STARTING THREE-PHASE MOTORS

In the original installment of this article which appeared in the February issue of the Journal the scheme of controlling motors arranged for this method of starting by means of an ordinary three-pole double-throw knife switch was discussed. A diagram showing the connections between motor, switch, fuses and line was included. The statement was made that by slightly modifying the connections, standard motor-starting switches could be used for this purpose.

Fig. 1 shows the connections of an enclosed switch of this type just recently placed upon the market. By comparison with the diagram given in the first article

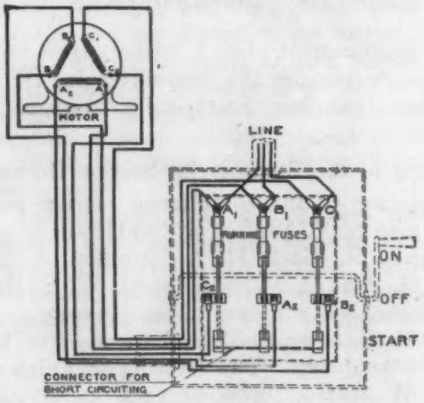


Fig. 1. Wiring Diagram for "Square D" Motor Starter, Star-Delta Type

it will be noted that the connections are identical except that the fuses form a part of the switch instead of being mounted separately. This switch is equipped with a spring-operated steel latch inside the cabinet so interlocked with the mechanism that the switch cannot be placed in the running position without having first been thrown into the starting position. This latch also makes a quick change from starting to running position necessary to prevent the switch being caught at the off point.

There are a number of other enclosed switches for this service now on the market. In two of the new types which have come to the writer's notice the operation of throwing over from starting to running position is done automatically by a spring arrangement at the instant the handle has been released by the operator after having been moved into the starting position. All types must be arranged so the switch cannot be left in the starting position since in this position the motor is without fuse protection. Further under these conditions the motor could not carry its full load.

A number of the later switches are of the so-called interlocking type. In these switches the fuses are placed in a separate compartment which has a door so interlocked with the handle that the fuses are accessible only when the switch is in the off position.

An oil-immersed drum type switch designed for this method of starting is illustrated in Fig. 2. There are three sets of contact fingers and segments upon the drum to effect the proper combinations of connections. Like the various switches just described, these drum switches are so arranged that the handle can only be moved into the different positions in the correct sequence. These switches are furnished in capacities up to and including 20 h.p. at 220 volts and

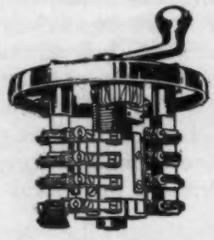


Fig. 2. Drum Type Star-Delta Switch of Cutler Hammer Manufacturing Company

25 h.p. at 440 and 550 volts and in three styles—with low-voltage release only, with low-voltage release and fuses or with low-voltage release and overload relays.

The connections for two of these styles are shown in Figs. 3 and 4 respectively. The push button in the low-voltage release circuit is for the purpose of tripping the switch from some distant point when desired. These buttons should be of the normally-closed type. A number of them may be connected in series when more than one tripping station is required.

By tracing the connections in the different diagrams it will be seen that the fuses are not in the circuit with the switch in the starting position and therefore protect the motor only when running. Note also that because of its position in the circuit each fuse carries the current for only one phase of the motor and therefore should have a rated capacity equal to 57.7 per cent of the full load current of the motor, assuming that overload capacity is not considered. Allowing 25 per cent overload as is now customary, this means that the ampere rating of the fuses should be 57.7 per cent times 1.25 equals 72 per cent of the full load current of the motor. For example, the full load current of the 7½ h.p., 220-volt, 3-phase motor mentioned in the first article, as shown on the motor name plate, was 19 amperes. The running fuses for this motor should then be 72 per cent times 19 equals 13.6 amperes, which would call for a standard 15-ampere fuse.

This point will be clear by referring to Fig. 5. Diagram (a) shows the relative position of the running fuses when the motor is started in the ordinary manner, either by being thrown directly across the line at full voltage as is done with small motors or by means of a suitable starting compensator in connection with the larger sizes. It will be understood that with either method of starting the running fuses are short circuited or removed from the circuit during the starting period.

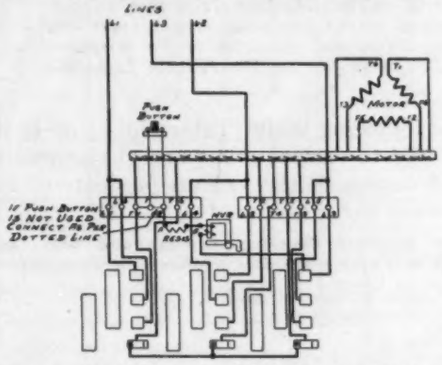


Fig. 3. Drum Type Switch with Low Voltage Release Only

Here the fuses are placed between the line and the junction of the windings and must therefore carry the line current which will be equal to 1.732 times the current in each phase of the winding. Diagram (b) Fig. 5, shows the relative position of the fuses in Fig. 1, after the switch has been thrown into the running position which connects the motor windings in delta. In this case, as explained, the fuses carry the current of only one phase of the motor, hence should be only 57.7 per cent of the capacity required with the fuses in the position shown in Fig. 5, (a). This does not mean however that fuses should always be selected in this way. With certain types of star-delta switches or starters the running fuses are finally connected into the position shown in Fig 5 (a). Therefore in every case the position of the fuses should be determined before their capacity is chosen.

If overload relays are used instead of fuses it is better to connect them so they will be in the main leads to the motor,—that is, in the same relative position as the fuses in Fig. 5 (a). In this position the capacity of the relay coils should be equal to the full load current of the motor, since these relays are generally designed to carry 25 per cent overload to agree with the present standard overload rating of motors. Placing the relays in this position will in many cases make the wiring easier and less complicated. Further there is the advantage that the relays will be of the proper capacity for use with a compensator should it be desired to start the motor in this manner at some later time.

In the future more care will be required in selecting relays and fuses as motor manufacturers are now re-rating or re-designing their lines of motors to agree with the new standards of ratings. Certain lines of motors will be given a maximum continuous rating that will not permit of the usual overload capacity. These motors will be known as "50-degree motors." A number of manufacturers already have lines of motors rated on this basis in production and will soon have them available for delivery. These ratings will be particularly suited for applications involving load requirements that are accurately known, such as the driving of individual machines. An article on these new ratings will appear in this department in the near future. For such motors, relays and fuses rated at 110 per cent of the motor amperes will probably be adopted as standard. Here it should also be noted that the usual double-pole circuit-opening relays which are extensively used for motor protection can only be used when starters are equipped with low-voltage coils.

With any type of switch having connections equivalent to those in Fig. 1, a separate main line switch must be installed ahead of the starting switch to completely disconnect the motor from the line. This is as required by the National Electrical Code. A sep-

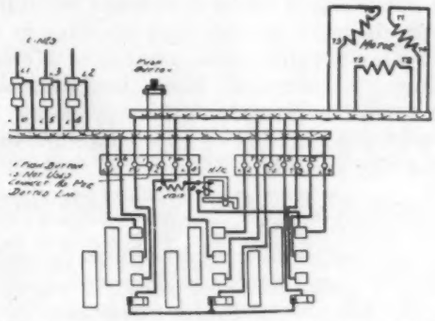


Fig. 4. Drum Type Switch with Low Voltage Release and Fuses

arate switch for this purpose is not required with the drum type switches shown in Figs. 3 and 4 since the motor is completely disconnected with the switch in the off position. This statement would not be applicable in the State of California in connection with those installations that come within the jurisdiction of the Industrial Accident Commission. The electrical utilization safety orders issued by that commission require that fuses, except in certain classes of lighting circuits, shall be disconnected from the source of energy before being replaced. Under these conditions a main line switch would also be required in connection with Fig. 4. Here it is also well to note that sec-

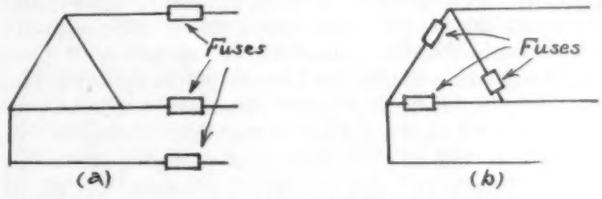


Fig. 5. Fuse Connections for Star-Delta Switches

tion 747 (d) of these same orders prohibits the use of any type of manually-controlled motor starter which does not give low-voltage protection, except where motors are under competent supervision and equivalent protection is otherwise provided.

The star-delta method is not by any means new. It has been discussed in detail because many of our readers do not fully understand it and because quite often it is used when conditions are not favorable thus causing much trouble. Again it seems of particular interest at this time because of the poor deliveries on starting compensators.

ELECTRIC POWER FOR IRRIGATION PUMPING

DEPARTMENT CONDUCTED BY S. T. HARDING

(Irrigation pumping by means of electrical energy has revolutionized the load curves of many hydroelectric companies throughout the West. Here is an account of how the San Joaquin Light and Power Company, serving the fertile San Joaquin Valley of California, is not only building up a load of immense profit to itself but is contributing a lasting service to the State in assisting the farmers of that wonderful community in producing an annual agricultural output valued at the enormous total of over one hundred and thirty million dollars. This article describes the extent and character of the irrigation pumping load of this community. The author is the valuation engineer for the San Joaquin Light and Power Company.—The Editor.)

UNUSUAL FEATURES OF AN IRRIGATION PUMPING LOAD

BY G. R. KENNY

The San Joaquin Light & Power Corporation is a large hydroelectric company that operates in the San Joaquin Valley portion of the counties of Merced, Madera, Kings, Tulare, and Kern, in California. The territory served has a population of about 250,000. Fresno, with a population of approximately 40,000, is the largest city served.

On January 1, 1917, there were 23,238 electric consumers connected with a total load of 57,567 kilowatts. The total number of irrigation pumping consumers on the same date was 887, with a connected load of 6965 kilowatts, or 12.1 per cent of the total. The consumption of these consumers for the year 1916 was 19,086,776 kw.-hr. or 23.7 per cent of the total kw.-hr. sold. The annual load factor of the business was 31.6 per cent. The monthly and daily load factors are very high.

The possibility of irrigation and intensive farming in the San Joaquin Valley first received attention about 1870. The first irrigation was entirely by gravity ditches.

The appropriation of water for ditch systems had reached almost its present proportions by 1890. At that time the question of ownership and appropriation of water had become very much involved and was settled by litigation extending over several years. The system of lateral ditches and the distribution of water has increased considerably since that time. Steam and gas pumping plants were first used for irrigation in this valley in the 90's. The first electric pumping plant was installed on the Mt. Whitney system in 1900. The San Joaquin Light & Power Corporation, whose predecessors had begun the service of light and power in 1896, connected its first irrigation pumping plants in 1906. Climatic and soil conditions are such that about all known crops can be raised, but necessitate the use of large quantities of water. The summer dry season extends generally from April to October, and the temperatures, particularly in June, July, August, and early September, are high. The daily variations in temperature in summer are usually from 25 to 40 degrees. The annual rain-fall and temperature are shown in the following table. (Table No. 1):

Table No. 1.—Climatological Data

Normal Annual	Merced	Fresno	Bakersfield
Rainfall, inches	14.72	9.67	6.5
Number of rainy days, 1914	44	43	25
Number of clear days, 1914	264	213	302
Mean annual temperature, deg	..	63	..
Maximum Recorded " " "	..	115	..
Minimum " " "	..	17	..

The following table (Table No. 2) gives the acreage devoted to various crops and the annual value of the total output of the various products of the territory served:

Table No. 2.—Data Covering Acreage and Value of Annual Output of Farm and Other Products in Territory Served

Total area in acres	15,648,610
Area adaptable to agriculture	7,710,000
Area under cultivation—	
Alfalfa	359,400
Dairying	219,000
Orchards and vineyards	324,576
Grain	559,850
Miscellaneous crops	34,000
Total area under cultivation	1,496,826
Value of Yearly Output—	
Dairy products	$ 9,160,000.00
Live stock	15,644,720.00
Alfalfa	10,267,000.00
Grain and hay	7,619,800.00
Citrus fruits	13,200,000.00
Raisins	5,260,000.00
Other fruits	14,494,775.00
Oil products	42,724,347.00
Other minerals	2,248,661.00
Lumber	4,300,000.00
Miscellaneous, small crops, mfg., etc.	7,325,765.00
Total value of yearly output	$132,345,068.00

The principal users of power for irrigation pumping are the alfalfa and citrus fruit growers, although all crops raised are irrigated and the area irrigated, to a greater or lesser extent, is practically the entire area under cultivation. In the counties served the 13th U. S. Census taken in 1910 reported 11,935 irrigated farms having a total irrigated area of 1,259,408 acres. In this area there were 1290 main ditches having a length of 2332 miles and 1847 laterals having a length of 3045 miles. In 1910 there were 211 flowing and 1920 pumped wells. The number of pumped wells has now increased to possibly twice this number.

The average quantity of water required annually for satisfactory irrigation for the various crops is as follows in acre feet per acre:

Alfalfa	3
Citrus fruits	2
Raisins, grapes and other fruits	1

The pumping lift varies from averages of 50 ft. to 110 ft. in the foothill regions east of Bakersfield and on the entire east side of the valley where citrus fruits are the principal crops, to 20 ft. to 25 ft. in the greater central section which is devoted principally to alfalfa raising, dairying, grapes, and other summer fruits. The west side of the valley is now attracting considerable attention. The lifts here are from 40 ft. to 90 ft.

At present, some rice is being grown by pump irrigation in the central part of the valley where alkali has prevented the growth of other crops and where the surface soil is underlaid with hardpan and clay. This industry appears to be a success. Electric power

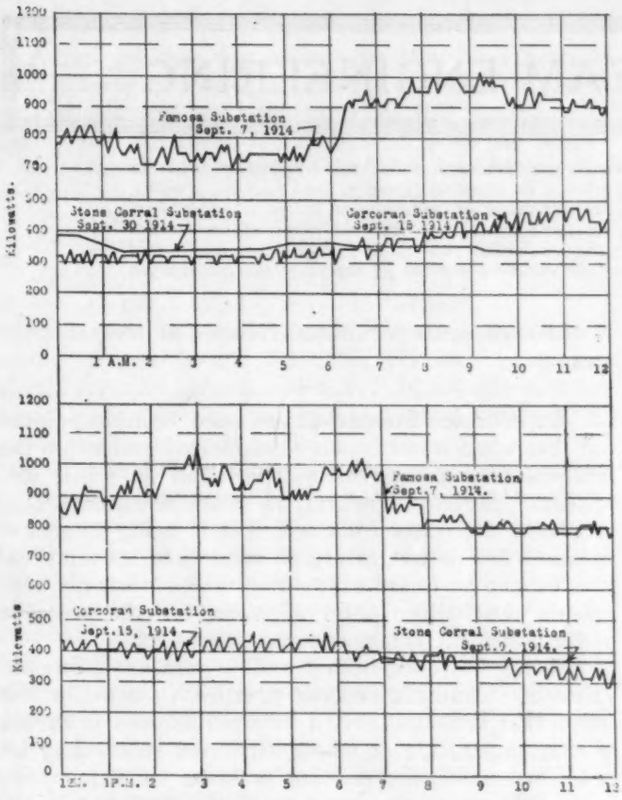


Fig. 1. Typical Daily Load Curves from Substations

is used for pumping almost exclusively. The amount of water required for rice is large, 3 to 5 acre feet per acre.

The effect of the irrigation pumping load is to increase the average summer load on the system over that in winter by about 5000 kw. The annual system peaks occur in August and September and are the result of the shortening days, bringing the lighting peak on top of the irrigation pumping load. The following table (Table No. 3) gives data on the operation of our substations serving practically nothing but irrigation business. The true diversity factor from consumer to substation was 1.16.

Table No. 3.—San Joaquin Light and Power Corporation. Data from Substations Serving Irrigation and Other Agricultural Business Almost Exclusively

Name of Station	Total Demands of Consumers Plus Average Line Drops for System	Sub-station Peaks	Diversity Factor	kw.-hr. for 1914	Load Factor
Famosa	1861.60	1544	1.20	6,129,600	45%
Corcoran	955.60	611	1.56	2,133,560	39%
Stone Corral..	963.25	706	1.36	2,340,000	38%
Madera 10 kv..	1103.99	705	1.57	2,245,920	36%
Totals	4884.44	3566	1.37	12,849,080	4.12%
Average Diversity factor			1.42		

In Fig. 1 are three typical daily load curves taken when the irrigation season was at its height.

The two typical daily load curves in Fig. 2 show the variation in the system load between summer and winter. These curves vary from those taken in 1916 only in the amount of load, the form being almost identical. A peak of 20.800 kw. was reached in August, 1916, and several peaks in excess of 20,000 kw. were recorded in 1916. The daily load factors vary from 60 per cent to 85 per cent. The annual system load factor for 1915 and 1916 was 61.2 per cent in each case.

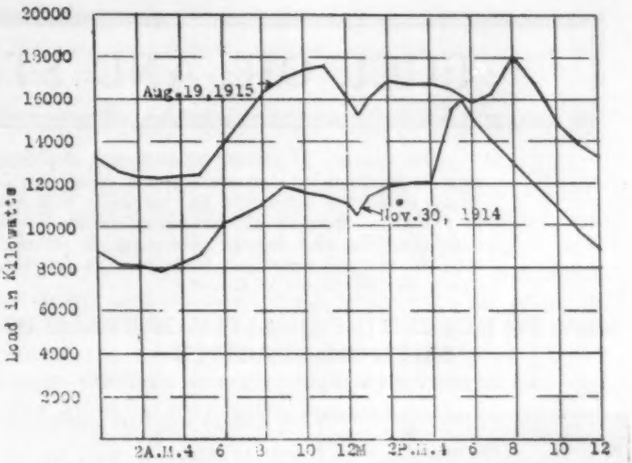


Fig. 2. Seasonal Load Curves of Typical Substations

(Continued from page 444)

between the range peaks. Together with the added cost of the double throw switch, it must be evident that the responsibility on the housewife to always remember to "throw the switch back" can but greatly lessen the value of automatic service.

With a gross minimum revenue of $50.00 earned by 1500 watts of step-thermally controlled apparatus. It is evident that since the 1.5 kw. connected load is imposed in graduated steps of only 250 watts each there is no additional copper, meter or transformer investment required when this type of apparatus is imposed directly on even a 5 kw. lighting service, for the resultant 250-watt-step disturbance has been noted to be less than the imposition of a flatiron or other 660 watt appliance. We will dedicate, however, to this heater its 1.5 kw. pro rata of investment, at $20.00 per kw., or $30.00, which develops a feeder, interest, maintenance and depreciation charge of 15 per cent of $30.00, or $4.50 per year. Deducting $4.50 from our minimum gross revenue of $40.00 per year, we have a net station revenue of $35.00 from 1.5 kw. total connected, or about $24.00 net per annum per kw. connected.

A brief resume of our results, then, shows the non-automatic service earning a net feeder revenue of $3.00 per year per kw. of load against $24.00 per kw. of investment dedicated to the automatic type of heater; or again, a net revenue per consumer of $15.00 per year from the 5 kw. heater against a net revenue of $35.00 earned by the automatic equipment, and lastly a gross revenue of $30.00 for the non-automatic against $40.00 for the step-thermally controllerd.

With respect to revenue per kw.-hr., the non-automatic, consuming 2400 kw.-hr per year, will develop from the above only ⅝c per kw.-hr., whereas the automatic will bring home $35.00 per year net from 3600 kw.-hr. or 1c per kw.-hr., which indicates the error in granting the two types of heaters the same unit rate per kw.-hr. Diversity is not considered for either type of heater, for they will both be on full-capacity during the dish-washing periods, and hence the 5 kw.-heater will develop no great diversity with respect to the domestic feeder alone than the 1.5 kw. heater, similarly considered.

It is not necessary for me to draw any conclusions—the fact standing self-evident is that the only barrier between the $3.00 per kw.-year and the $24.00; between the $15.00 net and the $35.00 net, is the application of properly directed sales effort and intelligence necessary to sell $60.00 worth of automatic service for $40.00 as against the sales effort necessary to sell $30.00 worth of non-automatic service for whatever we can get for it. That is, our net increase is purely a matter of salesmanship and what we go out to get, and it is certain that if we start out with a $30.00 idea it will never bring in $60.00 results.

FUEL OIL AND STEAM ENGINEERING

(The quality of steam, whether wet, dry saturated or superheated and to what extent moisture or dryness pervades its contents are matters of vast importance in steam engineering and fuel oil practice. In the following discussion the reader is told how the superheat of superheated steam is ascertained in practice. How to approximately determine the moisture content in wet saturated steam is also described. In this manner the way is paved for the discussion that is to follow next, which will set forth the exact methods to be used in determining the moisture content by means of the well-known steam calorimeter.—The Editor.)

HOW TO DETERMINE QUALITY OF STEAM IN FUEL OIL PRACTICE

BY ROBERT SIBLEY AND CHAS. H. DELANY[1]

Thermometer Inserted for Superheat Measurement

STEAM as used in engineering practice is said to be wet saturated, dry saturated or superheated, depending upon the degree to which heat has been applied in its generation.

Wet Saturated Steam.—As its name implies, wet saturated steam is saturated steam in which are suspended small globules or particles of water. Since such globules or particles of water indicate that insufficient heat has been applied, and consequently steam generation is imperfect, it is the function of all good boilers to generate steam as free from water as is possible.

Although steam be generated dry or even superheated it may, however, after passing through conducting pipes appear at the power generating unit in a wet condition. Hence the determination of moisture content and the heat loss due to its presence is an important one in steam engineering.

Let us assume X to be the proportion by weight of dry steam that exists in wet saturated steam. Then the total heat represented in every pound of such saturated steam at temperature t is

$$H_t = h_t + XL_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This is evident at once when we consider that to raise each pound of original water from 32° F. to the temperature t, it required h_t heat units. On the other hand since a proportion by weight equal to X has actually gone into steam, the heat required in the latent heat of evaporation is but XL_t.

Dry Saturated Steam.—As one may infer from the heading, saturated steam that contains no moisture is called dry saturated steam. In the chapter on properties of water the determination of its total heat was illustrated quite fully. We may, however, derive the equation for total heat of dry saturated steam from the equation above for wet saturated steam. For in this latter instance since no water is present, evidently X becomes equal to unity. Hence for dry saturated steam

$$H_t = h_t + L_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Superheated Steam.—It has been hitherto pointed out that when water is being evaporated into steam the temperature remains constant until all the water disappears. So long, however, as steam remains in contact with the water from which it is being formed it is either dry or wet saturated steam and its temperature cannot be raised above that which normally represents the boiling point of water for the pressure under which the steam is being generated.

It has, however, been found of immense economic value in steam engineering practice to actually use steam that is heated over a hundred degrees in excess of the temperature at which saturated steam may be generated under the existing pressure conditions. It is seen that such steam must, of course, first become absolutely dry and then any additional heat that may be added goes toward raising its temperature if the pressure be kept constant.

This is accomplished in the modern steam generating units by conducting the saturated steam from the main drums in which it is generated and passing it through pipes exposed to highly heated portions of the boiler furnace. Such a system of pipes is known as a superheater. The steam quickly absorbs sufficient heat to completely dry it and still further raise its temperature.

Computation of Total Heat of Superheated Steam.—If a definite constant quantity of heat were required to superheat a pound of steam one degree in temperature for all ranges of temperature and pressure, we could write down a comparatively simple formula for arriving at the total heat of superheated steam. Since, however, this specific heat constant has a wide range of .46 to .60 it is impossible to do so.

Hence in each case of temperature, pressure and degree of superheat, we must refer to steam tables in order to find the proper value of total heat of superheated steam. And, indeed, this too is necessary to find all the other constants that relate to superheated steam.

The fundamental definition remains the same, however—namely that the quantity of steam required to raise one pound of water from 32° F. to the temperature t corresponding to the boiling point of water for the pressure at which the steam is generated, added to the latent heat of evaporation for this pressure, together with such additional heat as may be required to raise the one pound of now dry saturated steam to the degree of superheat given, is known as the total heat of superheated steam H_s. Expressing this algebraically we have

[1]For an important announcement see editorial, page 454.

$$H_s = h_t + L_t + C_{pm}\,(t_s - t) \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

As an example let us suppose that superheated steam is being generated at ordinary atmospheric pressure and delivered at a temperature of 312° F. We will suppose that the mean specific heat C_{pm} for the range of temperature and pressure under consideration is say 0.46. Then from the tables, we find

$h_t = 180.$ $L_t = 970.4.$ $t_s = 312°.$

$t = 212°.$ $C_{pm} = .46$

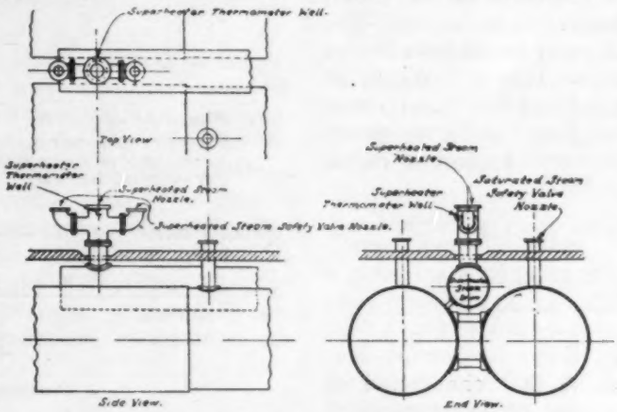
$\therefore H_s = 180 + 970.4 + .46\,(312 - 212)$

$= 180 + 970.4 + 46 = 1196.4$ B.tu,

It is most important that the student should remember that although the value H_s may be taken directly from the steam tables, still it is based on the several steps above taken. In many steam engineering problems this separate analysis or dissecting must be done so it is well to clinch this matter without delay.

Steam Calorimeters.—The word calorimeter often causes considerable confusion because there are two entirely different and distinct types of mechanism that bear this name in engineering practice. Fundamentally it means "a measurer of heat." In order to determine the heat contained in fuel an instrument known as a calorimeter is employed which will be described in later pages. At this point, however, we shall now proceed to describe several types of an instrument that bears the same name and yet is entirely different both in design and in aim to be accomplished.

The steam calorimeter is an instrument used in steam engineering practice to determine the exact quality of steam, whether it be wet saturated, dry saturated, or superheated, and to what extent. Since the thermometer and the carefully calibrated pressure gage constitute the easiest and most direct method of ascertaining superheat, the uses of the steam calorimeter are usually limited to determination of moisture in wet saturated steam.



TEMPERATURE DETERMINATION FOR SUPERHEATED STEAM

In taking the temperature for superheated steam a thermometer should be inserted as near the superheated drum as practicable. The thermometer has suspended at its side a second thermometer in order to ascertain the proper correction to be made for that portion emerging from the bath in which the main thermometer rests so that the stem correction may be made. In the illustration may be seen the point at which the thermometer well for ascertaining the superheated steam temperature was inserted in finding the superheat for an installation in Oakland, California.

The Determination of Superheat.—The method of ascertaining superheat will now be set forth.

A thermometer is inserted in the outlet of the superheater drum, and the temperature read, and at the same instant the pressure of the superheater drum is read on a steam gage attached to this drum. If now the thermometer reads 539° F. and the steam gage reads 178.5 lb. per sq. in. and the atmospheric pressure is 14.7 lb. per sq. in., we proceed as follows:

The absolute pressure of the superheated steam is the sum of 178.5 and 14.7 which is 193.2 lb. per sq. in. Referring to steam tables, we find that water boils, or rather saturated steam is generated, at a temperature of 379° F. when under a pressure of 193.2 lb. per sq. in. Hence, the superheat of the steam under consideration is the difference of 539° and 379°, which is 160° F.

Determination of Moisture in Saturated Steam.—There are many methods that may be used in determining the moisture content of saturated steam. The particular method to be employed depends much upon the accuracy desired and the degree or intensity of the moisture content present.

The Barrel or Tank Calorimeter.—In this method, which should never be used except for approximate results, the steam is allowed to pass up through a barrel of water. Of course, the steam at once condenses into water and the resulting mixture with the water in the barrel raises the temperature. By taking the pressure of the steam and the two temperatures of the water—the one before applying the steam and the other after its application together with the weights of the water involved, we may at once write a mathematical relationship to determine the moisture content.

If we neglect radiation and other stray losses, the heat gained by the water in the barrel is equal to that lost by the steam under test.

In all the subsequent discussions in this chapter let us let 0 subscripts represent conditions of steam in the boiler; 1 subscripts, the initial conditions in the barrel; 2 subscripts, the final conditions in the barrel; and W will represent the weights involved.

The total heat of each pound of entering steam is by equation (1) found to be $(h_0 + X_0 L_0)$ and since after this pound of condensed steam mixes with the water in the barrel it still has h_2 units of heat, there is then a net loss of $(h_0 + X_0 L_0 - h_2)$ heat units. In the same way each pound of water in the barrel gains $(h_2 - h_1)$ heat units. If W_0 units of steam are involved and W_1 units of water are found in the barrel at the beginning of the test, we know then, since heat lost by the steam is equal to heat gained by the water, neglecting radiation and other losses, that

$$W_0\ (h_0 + X_0 L_0 - h_2) = W_1\ (h_2 - h_1)$$

$$\therefore X_0 = \frac{W_1\,(h_2 - h_1) - W_0\,(h_0 - h_2)}{W_0 L_0} \quad \ldots\ldots (4)$$

As an example, it was found in a test that a steam main under 90 lb. pressure (gage) deposited 3 lb. of condensed steam into a vessel that contained 27 lb. of water at 62° F., thereby raising the temperature to 175° F. We compute the proportion of dry steam in the main as follows:

$P_0 = 90$ lb. per sq. in. (gage) $= 104.7$ lb. per sq. in. abs.

$W_1 = 27$ lb., $W_0 = 3$ lb. $t_1 = 62°$ F., $t_2 = 175°$ F.

Hence from steam tables—

$L_0 = 885.4$, $h_0 = 301.8$, $h_1 = 30.1$, $h_2 = 142.9$.

$$\therefore X_0 = \frac{27\,(142.9 - 30.1) - 3\,(301.8 - 142.9)}{3 \times 885.4} = .968$$

$\therefore X_0 = 96.8\%$ dry steam in steam under test.

Surface Condenser Tank Calorimeter.—This method varies from the one just set forth in that the condensed steam does not mingle with the water in the barrel. To accomplish this the steam is passed through a coil of piping which is inserted in the tank. As the steam comes in contact with the cooling surface of this pipe, it is condensed into water and of course the heat thus liberated or given out is absorbed by the water in the tank and its temperature correspondingly raised. Hence in this instance, it is necessary to weigh the water in the tank and the condensed steam discharged through the coil. It is also necessary to take the pressure of the steam under observation and to note the temperature of the tank water before and after application as well as the temperature of the water discharged from the coils.

Proceeding by similar reasoning as set forth in the former instance, the heat lost by each pound of steam is sure to be $(h_0 + X_0 L_0 - h_3)$, wherein the subscript 3 is to denote the condition of the steam condensed into water as it emerges from the coil. The heat gained by each pound of water in the tank is also seen to be $(h_2 - h_1)$ heat units. Hence if W_0 lb. of condensed steam are discharged and W_1 lb. of water are found in the tank, since the heat lost by the steam is equal to that gained by the water, neglecting radiation and other minor losses, we have

$$W_0\,(X_0 L_0 + h_0 - h_3) = W_1\,(h_2 - h_1)$$

$$\therefore X_0 = \frac{W_1\,(h_2 - h_1) - W_0\,(h_0 - h_3)}{W_0 L_0} \quad \ldots\ldots (5)$$

To illustrate, let us assume that one pound of steam at a pressure of 100 lb. per sq. in. absolute is passed through coils immersed in a tank containing ten pounds of water at an initial temperature of 100° F. At the conclusion of the condensation the water in the tank is found to be at a temperature of 204.5° F., while that emerging from the coils is 210° F. The quality of the steam is at once found by substitution in the formula as follows:

From the test data we have $p_0 = 100$ lb., $W_1 = 10$ lb., $W_0 = 1$ lb., $t_1 = 100°$ F., $t_2 = 204.5°$ F., and $t_3 = 210°$ F. From the steam tables, we find $h_1 = 68$, $h_2 = 172.5$, $h_3 = 178$, $h_0 = 298.3$, $L_0 = 888.0$.

$$\therefore X_0 = \frac{10\,(172.5 - 68) - 1\,(298.3 - 178)}{1 \times 888} = 1.05$$

Since the quality of steam is greater than unity, it is evident that the steam in this instance is superheated.

The principle upon which the more accurate steam calorimeters operate is in general accomplished along similar lines. We shall, however, reserve further discussion on the subject until the next chapter wherein we shall deal at length with these calorimeters.

LETTER TO THE EDITOR ON WIRING PROBLEMS

Martinez, Cal., April 23, 1917.

Sir: Will you please advise me on the following problems in interior wiring. Are they permissible under the National Electric Code? Are they safe?

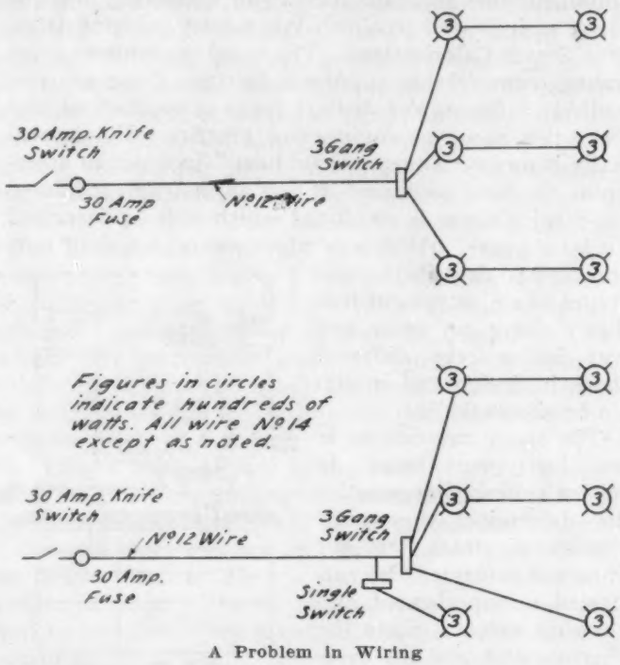
All wire double braided, rubber covered, in conduit in a concrete building; conduit bedded in the concrete.

An early answer will be very much appreciated as this is for an actual building, the construction of which will commence very soon.

Yours truly

MORRIS WENK.

Mr. C. W. Mitchell, electrical engineer for the Board of Fire Underwriters of the Pacific advises us that circuits as shown are overloaded. Section 23-d of the National Electric Code provides that not more than 660 watts shall be dependent upon one cut-out. However, by special permission in cases where wiring equal in size and insulation to No. 14 B. & S. gauge approved rubber-covered wire is carried direct into either socket or receptacle, and where the location of sockets or receptacles is such as to render unlikely the attachment of flexible cord thereto, the circuit may be so arranged that not more than 1320 watts will be dependent upon the final cut-out.


30 Amp. Knife Switch
30 Amp Fuse
No 12 Wire
3 Gang Switch
Figures in circles indicate hundreds of watts. All wire No 14 except as noted.
30 Amp. Knife Switch
No 12 Wire
30 Amp. Fuse
3 Gang Switch
Single Switch

A Problem in Wiring

If single conductors are used, wires need not be double braided as you specified. If twin, twisted pair or multiple conductor cables are used, then they should be double braided. In this connection please refer to Section 26-n of the Code.—The Editor.

To move one field army of eighty thousand men, technically known as a brigade, of field army troops, requires a total of six thousand two hundred and twenty-nine cars made up into three hundred and sixty-six trains with as many locomotives. These six thousand two hundred and twenty-nine cars would include two thousand one hundred and fifteen passenger, three hundred eighty-five baggage, one thousand and fifty-five box, one thousand eight hundred and ninety-nine stock and seven hundred seventy-five flat cars. Inasmuch as the army plans to move a million men, the railroads have a man's size job ahead of them.

SPARKS—Current Facts, Figures and Fancy

(Even the extinct craters of volcanoes are being utilized in the West for the storage of water as detailed in a fifty thousand dollar expenditure found below, which has received the sanction of the Corporation Commission of Arizona. Many other opportunities await but the magic touch of enthusiastic thought in the West, inspiration for which you may perchance catch by reading some of the "Sparks" detailed below.—The Editor.)

Eugene Christian has said that the best business man is he who can best harmonize his business affairs with his health, his happiness, and the philosophy of life.

* * *

From one of our contributors, with apologies to May issue of System, the suggestion is made to stencil, in bright paint, all ash cans so as to read: "Don't lug ashes all your life, Cook Electrically."

* * *

In Europe community forests have long been established and yield good returns on the investment they represent. The Swiss city of Zurich, for example, derives about twenty dollars per acre per year from a woodlot of twenty-five hundred acres.

* * *

In spite of the scarcity of oil scare that has received prominence in certain quarters the records show that five hundred sixty-three new oil and gas companies have been formed since the beginning of the war with an authorized capital stock of $666,000,000.

* * *

As central station representatives often have opportunities to talk before women's clubs and domestic science classes, it is felt that the well prepared lecture and lantern slides for this purpose, prepared by the National Electric Light Association, would be of advantage.

* * *

Contrary to general opinion the farm woodlots of the country not only furnish immense amounts of material for local use, but are important sources of supply for timber for the general market. Much of the choice hickory, ash, and white oak now in use comes from farm woodlots.

* * *

The largest turbine so far developed is rated at 70,000 kw. and the largest condenser on order has 100,000 sq. ft. (30,480 sq. m.) of surface. Many industrial plants are now installing units rated at 10,000 kw. and 15,000 kw., where 2000 kw. or 3000 kw. was considered large until recently.

* * *

The United States Attorney General has recently ruled that any alien enemy who tears down, mutilates, abuses, desecrates, or insults the United States flag in any way or displays an enemy flag or insignia is to be regarded as a danger to the public peace or safety and subject to summary arrest and confinement.

* * *

It has been suggested that some sort of co-operative school for teaching electric range cooking would be advantageous, and this, in turn, might be made the basis of a school operated by central stations, so that the electric range may be advertised through the training of those having to do with the cooking in the home.

* * *

The shipping board's survey of ships interned in the ports of the United States has disclosed that the three great steamships of the Hamburg-American Line —the President Lincoln, the President Grant, and the Pennsylvania—are the most extensively damaged of the German vessels. The repairs on each of these ships will approximate two hundred and fifty thousand dollars.

* * *

Attention is called to the importance of power company engineers co-operating with telephone engineers in the solution of inductive interference problems and informing themselves as to the principles on which means for mitigation of induction are based, so that they may be thoroughly familiar with the conditions in power systems which are likely to lead to inductive troubles.

* * *

Theodore P. Shonts of the New York Railways Company is impressing upon his host of employes that a street car conductor has three kinds of duties. First, he is in charge of the safety of his passengers. Second, he is a cashier and accountant. Third, he is an information bureau for passengers. These duties must be performed under all kinds of conditions, and always with courtesy and consideration for the public.

* * *

The consensus of opinion regarding the merchandising of appliances by central stations seems to be that they should be sold at a profit. This should be the goal toward which they should work with electric ranges, and the utmost help from all concerned is necessary to bring it about. Some central stations look forward to the time when electric ranges can be handled by dealers at a profit without the bonus for such sales which in some instances the central stations are paying at the present time.

* * *

The Corporation Commission of Arizona has granted permission for a corporation to pipe water from extinct craters lying in the greater altitudes above the city of Flagstaff to adjacent towns, so far away even as Ash Fork, Kingman, Seligman and Grand Canyon, and to ranches lying between. The line also will be the source of water for the locomotives, roundhouses and shops of the Santa Fe Railway. The United States Government has granted right of way for the pipe lines across the national forest intervening. The company already, has expended $50,000 in the enterprise.

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THE LIBERTY LOAN

The spirit of patriotic helpfulness is universal in America. From all over the country have come offers of co-operation from the newspapers and technical journals in the selling of the war bonds—The Liberty Loan of 1917. The government desires not only that the five billion dollars of bonds be sold promptly but that these bonds be as widely distributed among the American People as is possible. Engineers of the West know their duty and in the subscribing to this great patriotic move they will not be found wanting. Buy a bond for baby "bumpkin" now.

Youth in the West

An interesting thing about the estimated allotment for men of the draftable age from statistics of the U. S. Bureau of Census is the remarkable preponderance of youth in the West over other sections of the nation. Take the case of California for instance. In 1910 there were ten other states that exceeded her in population as a whole. When counting men of the draftable age at that date, however, only seven states exceeded her, while from present estimates it would appear that the Golden State is now at this date exceeded by but five other states out of the forty-eight.

The preponderance of youth in Western commonwealths augurs much for the future of this section. Her engineering achievements have long dazzled with their effective accomplishment the older and more conservative communities of the world. May her youth assist in making the world safe for democracy with the same brilliant and ever-conquering force shown in her past achievements in engineering.

Fuel Oil and Steam Engineering

Fuel oil and steam engineering discussions continue to hold the attention of engineers throughout the West. Since the first of the year this series of articles published in the columns of the Journal has created such wide spread interest and called forth such interested inquiry on the part of the readers of the Journal that this department in the future will be amplified and extended.

Beginning with this issue these discussions on fuel oil and steam engineering will be under the joint authorship of Robert Sibley, editor of the Journal of Electricity, and Charles H. Delany of the Pacific Gas & Electric Company.

In its entirety this series of articles will contain discussions of all important practical features involved in fuel oil and steam engineering practice. The principles involved will be set forth where necessary in simple mathematical treatment. No calculus will be used. Practical applications and industrial devices used in steam power plant practice will be discussed in their completeness and the closing chapters of the thirty-one distinct discussions will be devoted to set-

ting forth for the first time, definite and complete detailed forms for boiler testing in fuel oil practice.

It is believed that the joint authorship of Mr. Delany, who for so many years was an investigator with the Babcock & Wilcox Boiler Works and today is a well known authority on fuel oil applications in steam auxiliary practice, combined with the long experience of Mr. Sibley, as a teacher of these subjects, while holding the chair of mechanical engineering at the University of California, presents to the readers of the Journal an unusual combination for the discussions involved.

Conserve Fuel and Safeguard Service

Men of the electrical industry have followed with manifest approbation the recent move made by federal, state, and municipal authorities to protect the industrial activity of the nation. Thoughtful men who have within their power the directing of the public policy of the great hydroelectric activities throughout the West have not been slow in realizing the tremendous new responsibilities put upon their shoulders by the exigencies of the national crisis.

The question now to be considered is the immediate move to be made in order to conserve the fuel supply and safeguard the service of hydroelectric plants throughout the West.

In this section of the country crude petroleum is largely used as fuel and it is of utmost importance that its use should be curtailed in every reasonable manner possible. This can be accomplished by making the great powers in the mountain waters of the West available to their utmost.

A forceful instance of how fuel oil supply may be vastly conserved and the continuity of central station service placed upon a plane hitherto unattained is to be seen in California. Feeding San Francisco's great industrial districts are three large hydroelectric companies. Three great steam plants operated by fuel oil are required to assist the water power plants in the mountains. Interlinked, a vast saving could be effected, since the shortage of hydroelectric power in the one could be met by a call for hydroelectric power from the other oftentimes without a call upon the steam plant.

Stretching to the south into Los Angeles and its contiguous territory are three other large hydroelectric companies. Many smaller companies also pass through fertile valleys and serve thriving communities in this same commonwealth.

All of these power companies are consumers of vast quantities of crude petroleum and yet linked together the various loads could be made so to dovetail as to make a maximum use of water power and a minimum consumption of fuel oil. Here is an opportunity for real co-operative effort. Already many of these companies are interlinked but the connections as a rule are of insufficient capacity to carry the real burden should heavy duties arise due to disruption of service continuity.

This entire commonwealth should be made one gigantic network of interlinked pulsating energy. Such costs as may be involved should be considered from its emergency basis. Its early accomplishment is a necessary war move and the governor of the state, the fuel oil conservation commission, the council for defense and the managers of all power companies in California should take action immediately to bring about this step which will so positively accomplish conservation in crude petroleum and secure the highest attainable continuity of service.

Women in the Engineering Industries

Thoughtful men in hours of quiet reflection are speculating as to how this dear old world of ours will look after the thorough combing and grilling it is getting during the present strenuous days. The question of the possible entrance of women into the engineering industries due to the national crisis is of such vital importance to engineers that its discussion should receive full and unbiased treatment in the columns of the Journal. Undoubtedly the present war situation, whether we wish it or not, will force upon the engineering world the entrance of women in practically every phase of the engineering industries.

At a recent exhibit in England staid engineers of the present generation were simply amazed at the pictures displayed portraying the present activities of women in the United Kingdom, forced into these new lines of endeavor and yet withal making good in every way. Before the war these pictures would certainly have been unbelievable and would undoubtedly have been relegated to the curiosity shop where alone the dreamer dreams his dreams of unreality. But here they were displayed in actual reality—women engaged in a host of operations involving engineering in general, ship-building and marine engineering, tool-room and precision work, small arms works, the manufacture of parts of internal combustion engines; they show them engaged on wiring and rolling mills, operating all kinds of lathes and similar machinery, buildture work, assembling ironclad switchgear, erecting switchboards, driving 40-ton cranes, in charge of motors on industrial installations, driving electric trucks, operating a 500 kw. switchboard and attending a 300 kw. direct coupled set and a 1000 h.p. steam engine.

This entire question is not one of idle prattle for theorists. Its actual reality in this country may be upon us for solution in but a few months ahead. We should consider it from its broadest viewpoint. The women of our communities we must remember are our wives, our mothers, our sisters and our daughters. Steps should be taken at once to give them the highest training possible to meet the emergency.

And when the cloud and smoke of battle have cleared, unveiling a better and more harmonious world, may we not hope, too, that the emancipation of womankind may prove so effective and the reward of her patient suffering in the homes and in the industries so complete that she, too, may be included, so that we may all with one accord in reverence and with bowed heads say: "Yes, the world is itself at last free."

PERSONALS

H. B. Squires, electrical manufacturers' representative, has returned to San Francisco from an Eastern trip.

Dr. Thomas Addison, Pacific Coast manager of the General Electric Company, has returned to his San Francisco office from the East.

C. O. Martin, salesman with the Benjamin Electric Manufacturing Company, has returned to San Francisco from an extended trip through Southern California.

Geo. I. Gilchrest, research engineer with the Westinghouse Electric & Manufacturing Company at Pittsburgh, is studying transmission line conditions in California.

W. F. Allison, professor of highway engineering at the University of Washington, is at the Presidio in San Francisco training for the U. S. Officers' Reserve Corps.

F. W. Paterson has left the sales organization of the General Electric Company at San Francisco to take charge of switchboard sales for the company at Schenectady.

John A. Britton, vice-president and general manager of the Pacific Gas & Electric Company, is expected to return to San Francisco from a trip East in the early part of June.

L. A. Schloss, sales agent with the General Electric Company at San Francisco, has received his commission as first lieutenant in the officers' reserve corps and is now in the training camp at the Presidio.

G. D. Longmuir has resigned as district manager of the Pacific Power & Light Company at Pasco, Wash., to engage in business for himself with the Reliance Electric Company of Tacoma, of which he is one of the incorporators.

C. W. Mitchell, electrical engineer for the Board of Fire Underwriters of the Pacific has left for Chicago to attend the meeting of the Electrical Council of the underwriters laboratories which consists of twenty-eight members of that organization.

Paul A. Sinsheimer, head of the stock and bond department of the Railroad Commission of California for five years, has resigned his position to become assistant to the President of the Union Trust Company of San Francisco.

L. J. Corbett, dean of the department of electrical engineering, University of Idaho, has been appointed by Governor Alexander as one of the members of a state board of examiners of architects in accordance with the provisions of a law passed at the last session of the Idaho legislature.

Morton Macartney, city engineer of Spokane, was recently elected president of the Spokane Engineering & Technical Association at the annual meeting of the board of directors. Other officers for the ensuing year are: P. E. Morgensen, first vice-president; W. H. Linney, second vice-president; Carl Uhden, third vice-president; B. J. Garnett, secretary-treasurer.

E. J. Walsh, manager of the Tacoma District Heating Company, has tendered his resignation. **H. G. Lee,** chief engineer of the company, has been named as Mr. Walsh's successor. Before coming to Tacoma, Mr. Walsh was well known in Oregon industrial circles, having installed the system of the Northwestern Electric Company in Portland and the Port of Astoria docks.

Charles H. Lee announces that he has been assigned to duty as an engineer officer of the officers' reserve corps and during his absence his practice as consulting engineer will be directed by **W. K. Barnard,** Mem. Soc. Civil Engineers, of the firm of Leeds & Barnard, consulting engineers. **Raymond Matthew,** formerly head of the department of irrigation at the New Mexico College of Agriculture, will continue in his position as assistant engineer to Charles H. Lee and under Mr. Barnard's direction will be in immediate charge.

Lewis A. McArthur, general manager of the Pacific Power & Light Company, has been elected a member of the executive committee of the Northwest Electric Light & Power Association in the place of J. E. Davidson, resigned. **G. W. Talbot,** president of the Pacific Power & Light Company, has been appointed a member of the public policy committee in the place of Mr. Davidson.

O. C. Merrill, chief engineer of the Forest Service, with headquarters at Washington, though for many years a resident of San Francisco and vicinity, has just issued an interesting and instructive bulletin, in which he sets forth the manner in which the Forest Service is opening up the National Forests by road building under the proposed expenditure of twenty million dollars by the Federal Government during the next ten years.

Boyd Ehle, who will be remembered by his Western friends as resident engineer for Sanderson & Porter at Victoria, is looking after the wooden ship-building work which Sanderson & Porter contemplate carrying on for the government at Willipa Harbor, Wash. His headquarters are at Seattle. **J. S. Thornton,** manager of the Willipi Electric Company at Raymond, is also devoting much of his time to fathering the project as is likewise **P. A. Bertrand,** manager of the Gray's Harbor Railway & Light Company at Aberdeen, Wash.

M. A. De Lew, representing the Electrical Contractors' Association; **C. F. Collonan,** representing the Independent Electrical Contractors; **J. McKnight,** representing Local Union No. 6, Electrical Workers; **C. W. Mitchell** and **G. A. Cleary,** alternate, representing the Board of Fire Underwriters of the Pacific; **Arthur Kempston,** chief, department of electricity; and **S. J. Lisberger,** representing the Pacific Coast Section, N. E. L. A., have been appointed by the committee of public buildings of the board of supervisors of San Francisco for the purpose of revising the electrical ordinances of the City and County of San Francisco. The committee earnestly requests any suggestions, changes or amendments which would be of advantage to the electrical trade generally. Suggestions should be submitted in writing in order that the committee may have an opportunity to consider them.

T. E. Burger has resigned as assistant sales manager for the Western Electric Company on the Pacific Coast to become manager for Baker-Joslyn Co. at Los Angeles. This is another example of the strong hold that Southern California takes upon those who have once lived there. "Ted" Burger was with the Western Electric Company at Los Angeles for eleven years, having been manager of the house during the past seven years. Early in the present year he was promoted to the position he has just resigned, but the call of the South was irresistible, he could not get Southern California out of his bones, especially as his property holdings in that section of the country required his personal attention. Consequently, when the opportunity presented itself to acquire a proprietary interest in the Baker-Joslyn Company and direct their activities in Southern California, he decided to take up the new work. His many friends unite in wishing him all success, not least of whom are his former associates in the Western Electric Company.

MEETING NOTICES FOR ELECTRICAL MEN

(The Northwest Electric Light & Power Association convention at Spokane during September constitutes the most important date ahead for men of the electrical industry throughout the West. Not only are the men of this association themselves working for the success of this gathering but their enthusiasm has spread to the states to the south in such a contagious manner that active efforts are even now being made to formulate a special for the transporting of men of California and other states up via Portland and Seattle to attend this gathering. Details of the tentative program will be found below as will also be found other notations on meetings of interest to men of the electrical industry throughout the West.—The Editor.)

The Northwest Electric Light and Power Association

The program for the coming convention to be held in Spokane on September 12, 13, 14 and 15, 1917, is being rapidly brought to completion. Due to the N. E. L. A. and other fraternities calling off their conventions, some apprehension has been felt by certain of the membership as to whether or not the convention would be held as usual. This matter has been taken up with the prominent members of the association and it is felt that it is the duty of the president of the association to bring the convention to a successful conclusion, thereby expressing our confidence in the stability of our national government, and therefore it will be necessary for all of the members to bend their energies and assert their aggressiveness to a greater degree than ever, in order to accomplish this. Indications now point to a large delegation from other sections. The material so far gathered for the papers is of a very superior quality.

The program at this date, there being some changes in the personnel of some of the committees, and some additions, is as given below. The Washington association of electrical contractors and dealers will hold its first session in Thursday, September 13, instead of Wednesday, the 12th, as previously announced.

Wednesday, Sept. 12, 10:30 a. m.

Address of Welcome by the Mayor of Spokane.

Response by D. L. Huntington, president of the W. W. P. Co.

Committee reports.

President's address.

Paper by J. C. Ralston, a member of the American Society of Civil Engineers, entitled "Aphorisms."

Wednesday, Sept. 12, 2:00 p. m.

Paper, "Practical Central Station Salesmanship."

Editor-Chairman, Lewis A. McArthur, Pacific Power & Light Co., Portland; George Bowen, Northwestern Electric Co., Portland; S. A. Hoag, Puget Sound T., L. & P. Co., Seattle; H. W. Lines, Portland Ry., L. & P. Co., Portland; Lewis A. Lewis, Washington Water Power Co., Spokane; C. R. Young, Pacific Power & Light Co., Portland.

Thursday, Sept 13, 10:00 a. m.

Paper, "How the Engineer Can Assist the Commercial Department."

Editor-Chairman, D. F. Henderson, Washington Water Power Co., Spokane; Gilbert L. Duffy, Puget Sound Traction L. & P., Seattle; J. C. Henkle, Portland Ry., L. & P. Co., Portland; A. S. Hall, Pacific Power & Light Co., Portland; L. T. Merwin, Northwestern Electric Co., Portland.

Thursday, Sept. 13, 2:00 p. m.

Paper, "Co-operation in Modern Home and Apartment House Wiring Practice."

Editor-Chairman, A. C. Micken, Portland Ry., L. & P. Co., Portland; H. H. Schoolfield, Pacific Power & L. Co., Portland; L. R. Grant, Puget Sound T., L. & P. Co., Seattle; F. O. Broili, Northwestern Electric Co., Portland; Foster Russell, Washington Water Power Co., Spokane.

Thursday, Sept. 13, 8:00 p. m.

Illustrated lecture on "Commercial and Residential Illumination," by Mr. F. D. Fagan, manager G. E. Lamp Department on Pacific Coast.

Note: This will be highly interesting both to the convention and the public. The largest theater in the city will be engaged and all are invited to attend this lecture, which will be found both profitable and entertaining.

Friday, Sept. 14, Both Sessions

From 10:00 a. m. to 12:00 m., and 2:00 p m to 5:00 p. m., will be devoted to the Range Committee Report, Mr. W. R. Putnam of the Utah Power & Light Company, Salt Lake City, Utah chairman.

In connection with this report a paper will be read by Mr. H. B. Peirce of The Washington Water Power Company, on "Bus-Bar Diversity of Ranges" and one by Mr. B. L. Steele, professor of physics at the Washington State College at Pullman, Washington, giving results of certain tests made, as outlined in a previous bulletin.

Friday, Sept. 14, 7:30 p. m.

The usual banquet will be held in the Elizabethan room, Davenport's. (Informal).

Note: Visiting ladies will be adequately entertained each day.

The Program Committee feels the importance of continuing, year after year, a paper or bulletin entitled "Experiences and Wrinkles," the same to be compiled this year by Mr. Lewis A. Lewis of The Washington Water Power Company, Spokane. As outlined in my previous letter, a "Wrinkle" is defined as being "any device, short cut method, or experience, which has been worked out and used to advantage in carrying on your business." This of necessity cannot be a one-man production so I urge on you, in behalf of the editor, to send him any experiences or wrinkles which you may have gathered together. Your co-operation is absolutely necessary to put this over.

Saturday, Sept. 14. All Day

Arrangements have been made to visit the mine and smelter of the Bunker Hill & Sullivan Mining & Concentrating Company at Kellogg, Idaho, which company will then have in operation its new smelter. This mine is the largest lead-silver producing mine in the world, and the trip will be very instructive and enjoyable, including a boat ride across the beautiful Lake Coeur d'Alene, and returning to Spokane in time to catch trains going both east and west Saturday evening.

As an additional novelty on this trip it is proposed to hold a barbecue. The Bunker Hill & Sullivan Mining & Concentrating Company will extend all the courtesies possible to the convention delegates and their ladies and invites you all to be present.

In commenting upon the program President Osborn of the association has the following to say:

"This I think will be one of the most enjoyable excursions the association has ever held.

"After perusal of the foregoing I think you will all agree that your committee has prepared an excellent program; still, all that the committee can do is to point the way, and it is your duty to do the work as assigned you in the preparation of this program, efficiently and promptly, and so assist in carrying out the convention proceedings.

"It is my belief that in no way can we better show patriotism than by displaying the same spirit that we, as citizens of the United States, displayed in our declaration for national liberty, in making this, our first war convention, greater than all those preceding it. Let us have our business going on as usual."

The Portland Section of N. E. L. A.

The following officers have been elected for the ensuing year to manage the affairs of the Portland Section of the

BUILDERS OF THE WEST—VI

FRANK G. BAUM

The harnessing of water powers throughout the West has brought about unusual feats in engineering accomplishment that have been equaled in no other part of the world. In less than two and a half decades distances in transmission have grown from twenty miles to over five hundred, and voltages from five thousand to a hundred and seventy thousand. And the end is not yet. To F. G. Baum, an engineer of unusual gifts in installation and design of great hydroelectric plants not alone in this country but in our foreign neighbors to the south, this issue of the Journal is dedicated. And in this dedication emphasis is not laid so much on the gigantic material accomplishment of the builder as upon the spirit of confidence and fearlessness with which mechanical and electrical truths have been brought out in such great creations.

National Electric Light Association at Portland, Oregon: C. L. Warnicke, chairman; W. H. Lines, vice-chairman; R. J. Davidson, secretary; A. N. Cudworth, treasurer; G. N. Barker, J. C. Henkle, E. D. Searing, executive committee.

San Francisco Section, A. I. E. E.

After an intermission of two months the San Francisco Section of the American Institute of Electrical Engineers held its regular meeting on Thursday evening, May 24, 1917, at Elks' Building. The subject of the evening was "Modern Developments in Street Lighting," by F. C. Piatt of the Pacific Gas & Electric Company. Mr. Piatt has devoted practically all his time to this subject during the past several years and he spoke in an instructive manner and illustrated his talk with interesting models.

San Francisco Engineers Club

The San Francisco Engineers Club held a speakers' meeting on Friday, May 11, 1917, in the club rooms at the Mechanics' Institute Building. The speakers were Ira W. Howarth and H. H. Bliss of the extension division of the University of California. In a very able manner the speakers set forth the wonderfully effective work that is being accomplished among technical men throughout the State of California by means of the extension division of the University. E. O. Shreve of the General Electric Company acted as chairman of the day.

Los Angeles Jovian Electric League

F. M. Sinsabaugh, motor truck distributer, was chairman of the day on May 16th and introduced as the speaker of the day, Walter Wright Alley, engineer for the western department of the Wright-Martin Corporation. His subject was "Airplanes and Their Use in War." A fluent speaker and with a thorough knowledge of his subject, his talk was exceptionally interesting. With the industry still in its infancy, he outlined the recent phenomenal strides in aircraft constructon and stated that the big possibilities presented in this field open up unlimited opportunities to the young man with technical training.

New Mexico Electrical Association

The New Mexico Electrical Association has settled down to hard work through its various committees which have recently been appointed by President M. R. Buchanan. The complete list of officers and committees are as follows:

President, M. R. Buchanan; First Vice-President, J. R. Smith; Second Vice-President, D. W. Morgan; Secretary and Treasurer, Jas. A. Shepard. Executive Committee—M. R. Buchanan, W. P. Southard, C. M. Einhart, K. H. Meyers, W. F. Ritter. Appointive Committees: Membership—M. Nash, chairman; W W. McFarland, A. T. Stack, E. F. Sells, H. K. Bernard, Alex. Hibbard. Rates—W. S. Townsend, chairman; D. W. Morgan, K. H. Myers, Chas. Twogood. Program—C. M. Einhart, chairman; Sydney Ballinger, N. R. Stansel, Alec. Hibbard. Standard Rules—C. M. Einhart, chairman; J. R. Smith, J. J. Cooper, H. J. Wightman. Public Policies—W. P. Southard, chairman; F. P. Wood, J. J. Cooper, D. W. Low. Research—W. O. Vickery, chairman; B. C. Wheatlake, J. L. Brennaman, R. W. Goddard.

Southern California Electrical Contractors & Dealers

A get-together party was given by the Southern California Electrical Contractors and Dealers at Christophers, 741 South Broadway, Friday, May 18th, at 6:30 p. m. R. H. Ballard, general manager Southern California Edison Company, Ira J. Francis, general coast sales agent, John A. Roeblings Sons Company and D. J. Butts, manager Western Electric Company, spoke on subjects of vital interest. The entire affair was enjoyed by all present and closer relations between men of the electrical industry engendered.

The Southern California Electrical Contractors and Dealers announce the removal of their office and the office of the consulting electrical engineer, H. Conger Bowers, from 602 Metropolitan Building to 425 Consolidated Realty Building.

The San Francisco Electrical Development and Jovian League

The program for the meeting of the San Francisco Electrical Development and Jovian League on May 16, 1917, was given over to a consideration of foreign exchange banking methods by Harold Simpson, assistant to the foreign exchange manager of the Crocker National Bank of San Francisco. The speaker in an instructive manner outlined the immense activity ahead for commercial and engineering activity with our foreign neighbors. Stanley V. Walton of the Pacific Gas & Electric Company acted as chairman of the day. E. M. Cutting brought up the subject of electric vehicles and after a discussion by A. H. Halloran of the Journal of Electricity, H. P. Pitts of the Pacific Gas & Electric Company, Robert Sibley of the Journal of Electricity, and Colonel Carter, formerly of the Pacific States Electric Company, the meeting voted to call the attention of the Pacific Coast Section of N. E. L. A. concerning the matter and to express the willingness of the League to back them to the full force of its influence in bringing the electric vehicle and truck into its own.

The program for Wednesday, May 23, 1917, was unusually interesting. Captain Richard Park of the engineer corps of the United States army having been most fittingly introduced by Arthur Halloran, managing editor of the Journal of Electricity, proceeded to entertain his audience with a vivid description of the duties encumbent upon an officer in the engineer officers' corps. A little thrill passed through his audience when he predicted that but fifty per cent of those going to the front in France would probably return to this country. His patriotic remarks were accorded by the audience the sanction and approval they deserved. Stanley Walton of the Pacific Gas & Electric Company, reported excellent progress on the League's effort to assist the Red Cross by a subscription of five hundred membership.

Notes of California Railroad Commission

In the matter of delivery of water by water utilities during the emergency created by war, the commission has ordered as follows:

1. All water utilities are hereby authorized to deliver their surplus water, free or at reduced rates, for additional irrigation during the emergency created by the war.

2. Such water utilities, if deemed by them necessary to protect their legal rights, may require that land holders and irrigators desiring to receive water for the purposes and under the conditions specified in the opinion which precedes this order, shall first sign a stipulation agreeing that they their successors and assigns, will never claim that such delivery of water has amounted to or is evidence of a dedication or that it has in any way prejudiced the legal rights of the water utility.

3. Within thirty days after the delivery of water has been initiated by any water utility to any irrigator under the authority hereby granted, the water utility shall report to the Railroad Commission the name of the irrigator, the amount of water applied for, the land on which the water is to be used, the crop or crops to be planted and the terms and conditions, including the rate, if any, under which water is to be delivered by the water utility.

Notes of the California Water Commission

The following permits have been granted by the Commission:

Natomas Company of San Francisco, 50 cubic feet per second of the Sacramento River in Sacramento County for the irrigation of 6600 acres by means of a pumping plant, a main ditch 5½ miles long and 17 miles of laterals at a cost of $120,000.

Atascadero Mutual Water Company of Atascadero, 7 cubic feet per second of the waters of Salinas River for municipal and irrigation purposes. The water is to be drawn from wells in the bottom of the river by pumping plants and conducted to a reservoir capable of storing 60,000 acre feet. It is intended to water 23,000 acres and the cost of the project is estimated at $750,000.

OF INTEREST TO UTILITIES OF THE WEST

(Centralization of utility effort has long been recognized under commission regulation as the most effective means of creating efficiency and reducing costs of production. Below is an announcement of the authorization by the California Railroad Commission approving the combination of two great hydro-electric companies of Southern California into one of the largest utility units in the United States. It is believed that the net saving will be in the neighborhood of four hundred thousand dollars annually. This new venture under the doctrine of regulated monopoly will be watched with unusual interest by engineers throughout the West. Other announcements of interest to utility men will also be found in this column.—The Editor.)

A Gigantic Merger in Southern California

Authorization for one of the biggest power corporation mergers in the history of the country was given during the week just past when the Railroad Commission gave permission to the Southern California Edison Company of Los Angeles to buy the properties of the Pacific Light and Power Company for a price approximating $27,000,000.

The consolidated companies will represent a combined investment of $63,547,522.21. The deal will also give the Edison company control of the Ventura Power Company. The Edison company develops from hydro-electric plants on the Kern and Santa Ana rivers and from steam plants at Los Angeles, Long Beach and Redlands, a total of 119,800 horse-power. The company was originally a consolidation of a dozen or more smaller concerns, and serves sixty cities and towns in Southern California. The Pacific company develops, with its seven hydroelectric plants on the Kern River, Kern County, and Big Creek, Fresno County, and its two steam plants, about 150,000 horse-power. A large part of its business is supplying power to the electric railways of Los Angeles. The Ventura company furnishes electric light and power to about a dozen cities and towns.

WE'RE DOING OUR BIT
FOR PORTLAND!
Healthy Payrolls Are the Life Blood, the Nerve Fibre and the Muscle Builder of the Community
PAY MASTER
Portland Railway Light & Power Co
PAY ROLL 1907-1916
$24,219,488.47
PORTLAND RAILWAY LIGHT & POWER COMPANY

An Effective Publicity Campaign at Portland

The above matter which has appeared in large poster form is the effective work of the officials of the Portland Railway, Light & Power Company. The result has been that a distinct winning over of public sentiment has resulted and a stronger co-operative spirit aroused between the utility and the general public.

By the Commission's order, the Edison company, for the sum of $4,000,000 in cash, $12,029,900 par value of second preferred 5 per cent cumulative nonparticipating stock, is authorized to purchase second preferred stock of the Pacific corporation, $9,660,200; common stock, $10,468,500; first and refunding bonds, $5,000,000; notes and accounts, $1,096,048.41, and preferred stock of the Ventura Power Company, $341,750, and common stock, $704,500.

The Edison company also is authorized to purchase all of the franchises and properties of the Pacific corporation and issue in exchange therefor $11,421,800 par value of its common stock. The properties are being acquired subject to the outstanding bonded indebtedness. The Edison company will acquire all the stock of the Pacific corporation except first preferred, $382,500; second preferred, $318,400, and common, $91,000. Of the Ventura company's stock it will acquire all but preferred, $9030, and common, $1560.

The two concerns state the investment cost of their properties as follows: Edison company, at present, $30,-311,328; Pacific, $32,921,392. Adding to the sum of the foregoing $314,800.90, representing the value of the stock of the Ventura company to be acquired, the consolidated companies' total investment is $63,547,522.21.

Richard Sachse, chief engineer of the Commission, estimates the reproduction cost of the combined properties as of October 31, 1916, at $54,018,-235.50, and the reproduction cost, less depreciation, at $45,-266,386.54.

Commissioner Edgerton, who wrote the decision, says the consolidation is authorized only on the understanding that gradually the relationship between the property value and the capitalization be brought to a more conservative basis. The consolidation, he says, will cut down the capitalization and large savings will be made in operating expenses and greater efficiency will be brought about.

The companies estimate that the annual saving as a result of the merger will be $400,000. The Commission believes that the decrease proportionately in operating expenses will make it possible for the consumers eventually to have lower rates. The combined net earnings of the two larger companies for the calendar year 1916 was $1,500,969.82.

Public Utilities Commission of Idaho

In the matter of the application of the Utah Power & Light Company for a certificate of convenience and necessity in the village of Lewisville, Idaho, the commission granted the request.

In the matter of T. A. Walters, attorney general, complainant, versus Shelley Light & Power Company, Ltd., a corporation, defendant, Utah Power & Light Company, a corporation, intervenor, the commission has ordered that the present and future public convenience and necessity require and will require the construction by the Utah Power & Light Company of a transmission line from its generating station near the city of Idaho Falls to the south of the corporate limits of the village of Shelley in order to furnish electric power to the Utah-Idaho Sugar Company for the operation of its said plant, and also for any other service which may be required on the transmission lines so to be constructed.

LATEST IN EVERYTHING ELECTRICAL

(Wood stave pipe, a product of the West, is rapidly coming into its own as a necessary adjunct to hydroelectric development. Recent installations throughout the Northwest and especially that of the Pacific Gas and Electric Company on its Spaulding development in California emphasize this point. Here is an article by an author who is consulting engineer for the West Coast Lumbermen's Association of Seattle, Wash., that tersely sets forth the salient features of this important method of water conveyance. Its appearance at this time should meet with unusual interest from engineers throughout the West.—The Editor.)

THE USE OF WOOD STAVE PIPE IN HYDRO-ELECTRIC POWER DEVELOPMENT

BY O. P. M. GOSS

A Sixty-three Inch Creosoted Wood Stave Douglas Fir Pipe Line at Wenatchee, Washington

THE mountainous country adjacent to the Pacific Coast contains many valuable power sites, some of which have already been developed, and there are also many yet awaiting development. These projects usually require long pipe or flume lines to conduct the water to the point chosen for the power station. The lay of the surrounding country will usually determine the type of line to be used.

Wood stave pipe manufactured from Douglas fir staves has proven a very suitable form of pipe for this use. This material can be handled in small units, thereby simplifying transportation through rough and undeveloped country. It also has the great advantage of low first cost. This form of pipe lends itself most readily to the contour of the ground and it has throughout its life the lowest coefficient of friction of practically any form of pipe. The following quotation is taken from U. S. Department of Agriculture Bulletin No. 376:

"As shown by the table, the relative capacities change for various sizes of pipe and various velocities, but, speaking broadly, it is also shown that the capacity of wood-stave pipe is about 5 per cent less than that of a new cast-iron, 15 per cent more than that of a new riveted steel or 10-year-old cast-iron, and 25 per cent more than that of a 10-year-old riveted steel or 20-year-old cast-iron pipe."

Another very marked advantage in the use of wood pipe at this particular time is that it is so readily available. The wood is the one building material which has failed to increase in price in proportion to the general increase of other materials of construction, therefore, at the present time, there is a far greater difference between the cost for example, of a wood stave pipe line and steel than would have been the case two or three years ago.

Wood stave pipe, like any other material, must be intelligently used. If the pipe is to be built of untreated staves it should be under such conditions as to be practically always in service and should always be under a hydro static head of at least 20 ft. in order that the staves may be kept saturated, thereby preventing decay.

In the construction of such a line it is also very desirable that it be built up above ground, so that the outside portion of the pipe is always subject to the best of air circulation. Untreated pipe which is laid entirely or partly under porous, sandy or gravelly soil or which is empty during a part of the year, is subject to decay. A pipe line buried in a heavy clay soil which keeps the air away from the outer portion of the pipe, should cause no trouble from decay. Regardless of whether an untreated pipe line is laid above or under ground, it should be thoroughly painted on the outside first with a coat of hot coal tar creosote, followed by a coat of hot asphalt or coal tar. These paint coats add materially to the life of the pipe.

Continuous stave pipe which is exposed to the atmosphere is most subject to decay at the joints. The following quotation is taken from U. S. Department of Agriculture Bulletin No. 155 (professional paper).

"Decay of exposed pipe almost invariably starts at the ends of the staves as a result of leaky joints. Where water leaks out and runs down over the outside of the pipe, favorable conditions are afforded for the growth of algae which usually get a start, then mosses may begin to grow in the soil which collects on such spots and decay spreads to adjoining staves."

Wood is much more subject to attack by fungus on the end grain than on any other surface, which accounts for the development of decay at the end joints.

The following quotations are also taken from U. S. Department of Agriculture Bulletin No. 155:

"Contrary to the theories generally held 30 years ago, it has been found that the durability of wood pipe is usually dependent on the life of the wood rather than on the life of the bands."

"Where pipes are to be placed in contact with the soil and where the internal pressure is not sufficient to insure complete saturation of the staves, it is probable that their durability may be increased by treating with some preservative."

There is no question at this time but that an untreated wood stave pipe line intelligently built of

A Wood-stave Penstock Pipe for Hydroelectric Development

Douglas fir staves is a good investment. There are many of these lines in service and they are good for from 12 to 25 years. They are, however, subject to local failures due to development of fungus growth which might easily be prevented by suitable preservative treatment of the staves.

The most improved methods of creosoting are particularly suited to the treatment of Douglas fir pipe staves. The staves should be thoroughly kiln dried before treatment and should have from six to ten pounds of oil per cubic foot injected into the stave. The treatment should be done by boiling under a vacuum in such a way as not to injure the strength of the wood. The creosote oil goes in freely at the end of each stave, thereby protecting amply the weakest point found in the stave. Such treatment adds $20 to $23 per thousand feet B.M. to the staves, but does not materially increase the cost of the pipe line in place. This is due to the fact that there are a number of large items which remain constant regardless of the cost of the staves. The steel bands, the excavation, the back filling engineering, overhead, transportation and other costs remain constant regardless of whether or not the staves are creosoted. As a matter of fact, the final cost of the line in place if creosoted will be approximately 20 per cent more than that of an untreated line. There seems no reason to believe but that a thoroughly creosoted wood stave pipe line would last from 25 to 50 years under normal conditions. If conditions are very adverse, a thoroughly creosoted stave pipe line should last from four to six times as long as an untreated line.

One of the largest projects built to date of creosoted staves is that of the Reclamation District in the Wenatchee Valley. This line is approximately 8700 ft. long and is 63 inches inside diameter. It was constructed during the past winter and has just recently been filled with water for the first time. This line when filled was reported to be in excellent condition and is estimated to give a life of from 25 to 50 years.

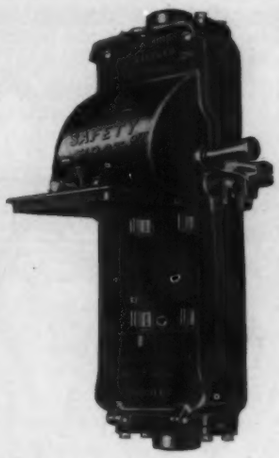
Similar lines constructed in connection with power development projects would prove thoroughly acceptable to the financing interests, since once installed such lines will have practically no maintenance costs and should outlast steel. The creosote treatment will thoroughly prove its ability to remove practically the only remaining defect, decay, in wood stave pipe.

AN APPRENTICESHIP COURSE OF RAILROADING

To meet the problem of securing trained railroad men and developing them for responsible positions, the Southern Pacific Company has established in San Francisco an "Agency School" under Superintendent of Telegraph King, where an apprenticeship course in railroad work is given and the student at the same time is paid while learning. The plan is proving highly successful. Boys coming from the country and ambitious to "get a start" master the course in from three to four months. Half the time is spent in the class room, and the balance in actual station work. Railroad telegraphy and all the duties of a station agent are taught. Officials of the company lecture to the students on all phases of the transportation question. There is still room in the school for more students. Good paying positions out on the company's lines await the graduates. Over sixty young men have acquired responsible positions in this way since the school has opened.

LATEST FORM OF "SAFETY FIRST" SWITCH

The Crouse-Hinds Company has placed on the market a line of condulets, called the MK series, which is of the highest order of "Safety First" construction. A Conduiet of this series consists of a fusible knife switch, inclosed in a cast iron body with hinged cover. A door in this cover furnishes access to the fuse compartment, but the design is such as to prevent this door from being opened when the blades are in the "on" position. Because of this latter fact, the person removing fuses is absolutely protected from receiving an electric shock.



The "Safety First" Switch

The switch is operated by a handle outside the case, and provision is made for locking this handle in either "on" or "off" position by the use of a padlock. While these Condulets are not regularly furnished with a quick-make and quick-break feature, they will be so furnished if purchaser desires. Of course, it is understood that whenever operating conditions require frequent opening and closing of the switch under approximately full load, the life of the arcing parts can be materially lengthened by equipping the Condulet with the quick-make and quick-break attachment. The illustration of type MKC Condulet, given herewith, shows the switch as it appears with the quick-make and quick-break attachment.

MK series Condulet possess another desirable feature in that they are provided with separable hub plates—variously, blank, single hub and two-hub plates. The latter two are made to take standard sizes of conduit from ½ to 3½ inches. This makes it possible to equip the Condulet for almost any arrangement of conduit installation and simplifies the work of installing.

Each type MK series Condulet is made in numerous capacities, ranging from 30-ampere, 2 or 3-pole, 125-volt, to 200-ampere, 500-volt, a.c. 3-pole switches, arranged for N. E. C. fuses.

Besides giving full protection against injury to persons operating the switch, a Condulet of this series is also a "Safety First" fitting in regard to itself. That is, it is dustproof, weather-proof and, because of its strong construction, both as regards the switch and the case, can stand the hardest and roughest usage. Full details regarding these Condulets are given in Condulet Bulletin No. 1000G. This bulletin will be furnished free to anybody applying for it to the Crouse-Hinds Company, Syracuse, N. Y.

COOPER HEWITT OUTFIT FOR ROTOGRAVURE PRINTING

For use in connection with the making of rotogravure prints, in which all newspapers are greatly interested at the present time, the Cooper Hewitt Electric Company of Hoboken, N. J., is marketing a special outfit. This outfit was built originally for the New York Times. It consists of six 67-inch, 7-ampere, mercury vapor tubes mounted in a stand, the auxiliaries with shifters being mounted at the end of the stand beneath the blower, as shown. The outfit is generally used with a printing frame on each side. Rotogravure prints are made from metal at the rate of about 3500 per hour. The process of making the print consists of using for copy anything that would make a good halftone. From the copy a negative photographic plate is first made. From this a positive is made, which is the

reverse of the negative. This positive is a gelatine film and goes directly to the layout table to be assembled by experts on glass in its proper relation and position with other negatives. When properly assembled, it is brought into contact with a carbon tissue which is a gelatine covered sheet of paper. The carbon tissue is then printed from the positive by means of a strong light, and it is for the purpose of furnishing the required light that this Cooper Hewitt outfit is utilized.

A CAMPAIGN FOR SELLING THE ELECTRICAL IDEA

The window display is one of the best ways of selling the electrical idea. The contractor and dealer scarcely realize the immense importance of this kind of publicity in meeting the trade. Here is a typical display window for selling the electrical idea that was called to the attention of thousands of contractors and dealers last season. Time is now ripe for initiating new and bigger plans, for the coming season. No contractor or dealer can afford to let these days pass without giving time and thought to the important problem of effective window display.

HEAVY DEMAND FOR ELECTRICAL APPLIANCES

Joining forces with the present prosperous condition of the country at large, the educational work of electrical appliance manufacturers and the electrical industry, is bearing a heavy crop of fruit.

For many months, the capacity of electrical appliance manufacturers has been taxed to the utmost and while the managements have been seeking for ways and means to increase the capacity without going beyond a normal growth, purchasing agents have scoured the market for raw material with which to satisfy the demand of the American home.

The fact that housewives the country over are advocating the home electrical, is brought forcibly to our notice by the information which comes to us from the offices of the Hotpoint Electric Heating Company with headquarters at Ontario, California.

Our representative reports from an authorized interview that the Hotpoint Company's business for 1916 came nearly doubling the business for 1915. The information conveyed is to the effect that this company which is reputed to be the largest in the world devoted exclusively to the manufacture of electrically heated appliances, has been carrying for many months, unfilled orders amounting to tens of thousands of appliances and that it has been necessary to parcel out among the trade, goods as rapidly as they could be supplied by working all factories to capacity and pressing into service special facilities that could be commanded.

A NEW JOINT BOX FOR SUBMARINE CABLES

In placing electric cables in underground conduits or in laying them on the bottom of a body of water, frequent joints are necessary. These are apt to be weak spots both electrically and mechanically unless properly made and protected. A new and improved type of joint-box or housing for use on submarine cables has recently been developed and perfected by the Standard Underground Cable Company, and successfully used on submarine cables supplied the Atlantic City Electric Company for the U. S. Ship Canal at Atlantic City, and the Wilmington & Philadelphia Traction Company and Pennsgrove Light, Heat & Power Company for crossing the Delaware River at Wilmington, Del. It was also used in Canada on submarine cables of the Halifax Electric Tramway Company and the City of Ottawa Water Works Department.

NEW BULLETINS

The Carnegie Institution of Washington has just issued a fifty-page pamphlet covering its annual report on terrestrial magnetism.

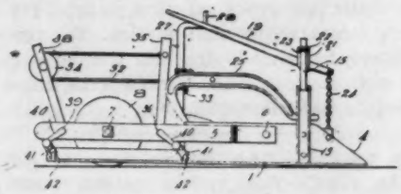
Investigations of the economical duty of water for alfalfa in the Sacramento Valley of California have appeared in Bulletin 3 of the department of engineering, State of California.

WHAT WESTERN INVENTORS ARE DOING

(Since the drift of all utility activity is now "back to the farm," the brief included below on a new ground-leveling machine presents unusual interest to engineers throughout the West as a move in the proper direction for inventive talent. Other interesting patents by Western inventors on apparatus for charging storage batteries, an electrical toy, a new lineman's device and an electric water-heater are also recorded in the following lines.—The Editor.)

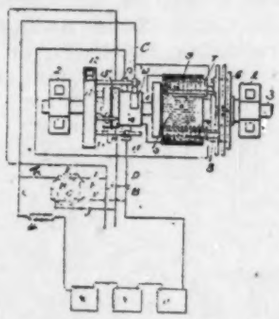
1,223,831. **Ground-Leveling Machine.** Henry J. Reed, Townsend, Mont.

A land-leveling machine, the combination, of a pair of side runners, a scraper blade carried by the runners, a pair of arms connected to the runners, an axle carried by the arms, a roller rotatably mounted upon the axle and positioned rearwardly of the scraper blade, a pair of substantially U-shaped channel irons attached to the runners adjacent their forward ends, a pair of standards slidably and rotatably carried by the channel irons, supporting wheels carried by the standards, pins extending diametrically through the standards adjacent their upper ends, saddles slidably mounted upon the standards and resting upon the pins, levers, pivotally connected to the saddles, flexible members connected to the forward ends of the levers and to the front ends of the runners for raising the front ends of the runners upon downward pivotal movement of the handle ends of the levers.



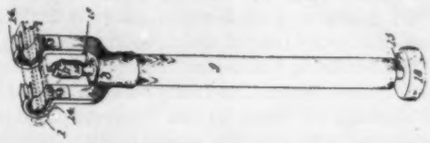
1,223,471. **Apparatus for Charging Storage Batteries.** Arthur R. Bullock, Cleveland, Ohio, assignor to Henry C. Lee, trustee, Los Angeles, Cal.

A combination with a device for producing a pulsating direct current a circuit for supplying electric current thereto, of a storage battery to be charged by the device, an electrical connection between the battery and the device, a reactance coil in the connection and in series with the battery, and a circuit containing capacity connected between electrically connected sides of the current supply circuit for the first mentioned device and across the circuit of which the battery is a part.



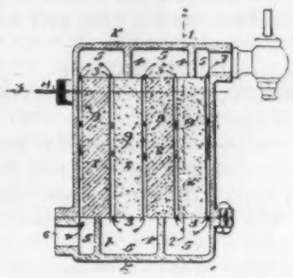
1,223,791. **Lineman's Device.** Van Buren Jackson, Pedro Miguel, Canal Zone, assignor to San Diego Consolidated Gas and Electric Co., San Diego, Cal., a Corporation of California.

A lineman's device for making a connection to a high potential live line wire consisting of a clamp having means of securing a tap wire thereto, the clamp further having a pair of elongated oppositely disposed jaws disposed one above the other with a channel extending longitudinally between the jaws constructed to receive the line wire in a position extending longitudinally in the channel between the jaws when the clamp is moved laterally onto the wire, the outer sides of the jaws being substantially flat and parallel with each other to enable the clamp to be held yieldingly in a holding device engaging the outer sides of the jaws, the lower one of the jaws having screw means attached thereto for securing the line wire in the channel, the screw means having a form to detachably interlock a screw-rotating device.



1,224,117. **Electric Water-Heater.** Samuel D. Nesmith, La Jolla, Cal.

An electric water-heater including a casing having a top and a bottom one of which is removable, the top and bottom each having integral inwardly extending partitions, a body of insulating material having a series of flat water passages molded therein, and electrical wires embedded in the body adjacent the sides of the water passages, the body being insertible as a unit in the casing and engaged at its top and bottom with the free ends of the partitions so as to be supported by the partitions of the bottom.



1,223,375. **Electrical Toy.** Gale S. Elliott, Needles, Cal.

An electrical toy, comprising electromagnets, a rotating armature consisting of a metallic frame structure, a means for making and breaking the circuit between the electromagnets and the rotating armature consisting of tongues bent from the metallic frame and a fiber ring arranged within the tongues, and a brush operatively associated therewith.

NEW ELECTRICAL DEVELOPMENTS

(Continued reports from the Northwest relative to the extensive plans for electrification of the Chicago, Milwaukee & Puget Sound to the West of its present efficiently electrified lines over the Rocky Mountains constitute the most interesting news of the past two-week interval from that section, while to the south in Los Angeles interest centers on the twelve million dollar bond issue that is to be voted upon on June 5, 1917, relative to the city's acquiring the present distribution lines serving that municipality. Other items of interest in new electrical developments throughout the West may be gleaned from the following lines.—The Editor.)

FINANCIAL

SAN FRANCISCO, CAL.—Girvin & Miller, Kohl Building, San Francisco, and Torrance, Marshall & Co., 111 East Fourth street, Los Angeles, are now selling series A 6 per cent convertible gold debentures of the San Joaquin Light & Power Corporation, the total issue of which is $1,000,000.

SAN FRANCISCO, CAL.—An intervention suit has been filed in the United States District Court on behalf of Christopher M. Bradley, an owner of the Northern Electric second mortgage bonds. The court is asked to find that the Northern Electric Railway never had legal authority as a railroad to issue the first mortgage bonds, and that the second mortgage bonds are the only existing valid claim upon the property of the company.

OAKLAND, CAL.—Suit for $100,000 against the Western Power Company has been filed by the city of Oakland. The suit was brought in accordance with a resolution voted by the city commissioners. The money is alleged to represent profits due the city upon the percentage plan under which the power company agreed to pay the city 2 per cent on the gross earnings in consideration for the franchise privileges. This money, it is contended, has not been paid for two years.

ILLUMINATION

SAN FRANCISCO, CAL.—The supervisors will receive bids on June 4 for city lighting.

VENTURA, CAL.—The Ojai Valley Men's League has authorized the establishment of 13 street lights.

PORTLAND, ORE.—The city council will not submit the $1,777,000 bond issue for a municipal electric light plant at the election June 4.

CHESAW, WASH.—An electric light plant to supply the business houses, residences and streets of Chesaw is among the 1917 improvements forecasted.

SALINAS, CAL.—The plans and specifications prepared by Consulting Engineer Phillips for the proposed electrolier system, have been presented to the city council.

HANFORD, CAL.—Within sixty days ranches in what is known as Sunset Colony, will be furnished with electric light and power by the San Joaquin Light & Power Company.

VALLEJO, CAL.—The Vallejo Electric Light & Power Company has secured the contract for installing the lighting system in the new Masonic Temple to be built at a cost of $55,200.

BAKERSFIELD, CAL.—Separate sealed bids will be received by the county board of supervisors up to June 5 for the construction and maintenance of an electric lighting system in the Wasco lighting district.

LIVINGSTON, CAL.—A lighting system is to be established in this city. Plans are being made for the formation of a district, President G. H. Winton, Secretary E. G. Adams and Director W. J. Hunt being in charge.

RIVERSIDE, CAL.—The common council received bids up to May 25th for the improvement of Main street between Fourteenth and Tenth street, by the erection on each side of the street of poles, conduits and lamps for lighting purposes.

HALFWAY, ORE.—The streets of Halfway will be lighted with electric lights on or about October 1, according to a contract given to the Idaho Power Company by the town council. The contract runs for 10 years. The cost of building the line into the valley will be $70,000.

YUMA, ARIZ.—The city council has under consideration a proposition for bonding the city to buy the old water and light plant and making necessary additions to bring it up to date. The city engineer has placed a valuation on the old plant at $160,000 and the cost of completing a municipal plant at something over $300,000.

RIVERSIDE, CAL.—At a meeting of the board of public utilities, the electric light department was authorized to build a line to the Highgrove pumping plant of the University of California citrus experiment station, the installation to cost about $1800, to be made provided the department cannot secure power from one of the private companies at a cost not to exceed 1c per kilowatt hour.

TRANSMISSION

ASTORIA, ORE.—The port of Astoria commission has decided to install its own power plant here for operating the machinery at the port elevator and coal bunkers.

TACOMA, WASH.—An ordinance has been passed authorizing the Wheeler Osgood Company to construct and maintain an electric transmission line upon Railroad avenue.

PORTERVILLE, CAL.—Surveys are in progress for the new power plant which the Mt. Whitney Power & Electric Company has to put in the foothills above the Forks on the road to Camp Nelson.

TACOMA, WASH.—A franchise has been granted to the Puget Sound Traction, Light & Power Company for a period of 50 years, to construct and maintain a transmission line along the public highways in Pierce County.

DOUGLAS, ARIZ.—A plan to run a power line from Elephant Butte dam to Kingston to furnish cheap power for mine operators is being considered. The line as planned would run via Chino, Silver City, Kingston and Tyrone, N. M.

LOS ANGELES, CAL.—Whether the city shall issue bonds aggregating approximately $12,000,000 to consummate the proposed power deal with the Pacific Light & Power Corporation and the Southern California Edison Company, will be decided at a general election on June 5th.

SEATTLE, WASH.—The following pole line permits have been granted the Puget Sound Traction, Light & Power Company: On the county road No. 68 from Stevens street south, on West 145th street, on North Trunk Boulevard, on Palatine avenue north of 110th street, and on the Homer Crosby road west of McEachern road.

GOODSPRINGS, NEV.—Capital has been pledged and preliminary work is to be begun soon on the erection of a hydroelectric plant above Bend to generate power for the Goodsprings and Yellow Pine mining district from the Colorado River. It is proposed to deliver the power to places in Arizona, and in Nevada to points as far north as Ely and Pioche.

OLYMPIA, WASH.—The Puget Sound Traction, Light & Power Company, of Tacoma, has made application to the county board of commissioners for a franchise for a transmission line from the Nisqually River to the Log Cabin between Olympia and Tumwater. The hearing of the franchise has been set for June 4.

OROVILLE, CAL.—Engineers for the Great Western Power Company are completing detailed surveys for the dam near the junction of the North Fork and West branch. The specifications for the power plant and for the canal are also being completed, and it is believed that plans will be in

shape within the next six weeks for starting construction work.

CORCORAN, CAL.—The sum of $80,000 is to be expended by the San Joaquin Light & Power Company for a substation to be built 6 miles south of Alpaugh. The new station will supply the rice fields west of Pixley and the Alpaugh and Allensworth districts. The southern end of the big development work of the Tulare Lake Water Company will also be supplied from the new station.

KALISPEL, MONT.—W. B. McDonald of the Northern Idaho & Montana Power Company has applied for a 50-year franchise for light and phone in the city of Ronan. In the event of getting the franchise the Northern Idaho will extend the power line down the east shore of Flathead and on to Ronan. The company has already been granted a permit to run its line along the county road on the east side of the lake.

MARTINEZ, CAL.—The Great Western Power Company will complete in a few weeks its high tension power line from Moraga Valley through Lafayette, Happy Valley and Briones to Crockett to connect with its high tension lines from Antioch and Napa. Steel towers, 80 ft. high, will carry the four cables. The substation on the hills above Crockett will be one of the largest in the state, and will be the central distributing plant for the bay territory.

PLACERVILLE, CAL.—The Western States Gas & Electric Company plans to expend over $1,000,000 in power development in El Dorado County. Surveying crews already are in the field along the South Fork of the American River, where additional power developments will take place. According to present plans a dam will be located on Medley Lake in Desolation Valley; another dam will be at Twin Lakes. A tunnel 2500 ft. long will be constructed under Echo Lake.

REDDING, CAL.—R. C. Starrett, civil engineer for the Pacific Gas & Electric Company and W. A. Cooper, general manager of the Mt. Shasta Power Corporation, which has sold its rights in the Big Bend of the Pit River to the former company, passed through Redding recently on their way to the power plant site in the Big Bend. Starrett will survey some roads for hauling in supplies. The work of driving the tunnel will proceed with a crew at each end. The aggregate length of the tunnel is now a little over a mile. The money is on hand to push the work according to the schedule for the expenditure of the $17,500,000 required for the completion of the power development.

TRANSPORTATION

RIALTO, CAL.—Preliminary work is under way for beginning construction of the new Pacific Electric spur track between Riverside avenue and Date street.

LOS ANGELES, CAL.—An order has been made by the board of supervisors directing the clerk of the board to advertise for sale a franchise for the construction of an electric railway on Highland avenue.

SACRAMENTO, CAL.—That the Western Pacific Railroad Company is prepared to enter into negotiations for the purchase of the Northern Electric Railway Company now in the hands of a reorganization committee, was announced by Charles M. Levey, president of the Western Pacific Company at a meeting of the committee.

SAN FRANCISCO, CAL.—G. K. Weeks was re-elected president of the California Electric Railway Association at the annual meeting held in the Palace Hotel. W. Clayton was re-elected vice-president and G. K. Weeks, Paul Shoup, Jesse W. Lilienthal, W. E. Dunn, W. Clayton, W. R. Alberger and W. V. Hill were elected to the executive board.

KLAMATH FALLS, ORE.—Robert E. Strahord of Portland has arrived in Klamath Falls. It is expected he will start operations soon on the constfuction of the Klamath Falls Municipal Railway. Klamath Falls is ready now, the city having passed the bond issue, secured the $300,000 and accepted Mr. Strahorn's bid on the contract for construction, which only remains to be signed up by the city and himself.

SALEM, ORE.—Total valuation of the property of the Portland Railway, Light & Power Company useful in public service, and upon which it is entitled to base its rates to the public, is $46,862,972, according to the findings of the Oregon Public Service Commission, made public recently as a conclusion to the biggest valuation case ever handled by the commission. This sum is approximately $14,000,000 less than the valuation for rate making purposes urged by the engineers for the company.

TELEPHONE AND TELEGRAPH

SAUSALITO, CAL.—The trustees have adopted a resolution ordering that a telephone franchise be offered for sale.

LATON, CAL.—The telephone system which was purchased by T. D. Marshall recently from the Laguna Reclamation District, has been connected with the Laton switchboard.

OAKLAND, CAL.—The Pacific Telephone & Telegraph Company has completed plans to build an addition to its structure on Franklin street and will double the capacity of the plant.

BENSON, ARIZ.—It is probable that a new toll center will be established by the Mountain States Telephone & Telegraph Company, either at Dragoon or Johnson in the near future.

VENTURA, CAL.—An ordinance has been adopted by the board of supervisors granting the Oak Ridge Oil Company a telephone franchise upon certain public highways in Ventura County.

FLORENCE, ARIZ.—A crew has been engade stringing telephone wires on the new poles recently put in from the depot to town. A new line is also being strung from Mesa to Florence, and general repair work is in progress throughout the town.

KERMAN, CAL.—The Kerman Telephone Company has announced that work will begin at once on the construction of 50 miles of new telephone lines. Besides the company will make considerable improvements to the switchboard in the exchange building.

YUMA, ARIZ.—The Yuma County Water Users' Association proposes to amend its constitution and by-laws so as to empower the association to tax its members for the purchase and operation of utilities such as telephones, power, light, etc. This move is to pave the way for a proposition to tax every acre of land under the project to raise money to put in an independent telephone system.

IRRIGATION

BRAWLEY, CAL.—Surveying is being conducted at La Balsa, Mexico, for an irrigation project.

PARADISE, CAL.—The Paradise irrigation district directors have let the contract for the distributing system to W. H. Kramer of San Francisco at a figure approximating $160,000. Redwood pipe, instead of steel, will be used.

SACRAMENTO, CAL.—Steps are being taken for the organization of an irrigation district containing about 8000 acres in Hayfork Valley. Water will be taken from Hayfork Creek. $160,000. Redwood pipe, instead of steel, will be used. Engineer, Salem, Oregon.

ANDERSON, CAL.—Twelve carloads of mules and equipment have arrived here, being consigned to the Shattuck, Edington Company, of Los Angeles. This company recently took the contract to complete the major part of the excavation work on the Anderson-Cottonwood irrigation district.

FRESNO, CAL.—The first active step has been taken for the organization of the Kings River Conservation District, the building of the dam at a cost of $9,000,000, and the irrigation of 1,116,000 acres in Fresno, Kings and Tulare Counties. It has been decided to begin immediately the organization of ten or more unit districts.

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Los Angeles; 755 Folsom St., San Francisco; Seattle.

B-1 **Baker-Joslyn Company** 3
71-75 New Montgomery St., San Francisco; 911 Western Ave., Seattle; 353 Second St., Los Angeles.

B-2 **Benjamin Electric Manufacturing Co** .....
590 Howard St., San Francisco.

C-1 **Century Electric Co** 13
906 So. Hope St., Los Angeles; 56 Natoma St., San Francisco; 65 Front St., Portland, Ore.

C-3 **Crocker-Wheeler Co** .....
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C-5 **Crouse-Hinds Company** .....
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New York, Boston, Cincinnati, Chicago.

C-4 **Cutler-Hammer Manufacturing Co** 19
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E-1 **Edison Lamp Works of General Electric Co** .....
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U-1 **United Sheet Metal Works** .....
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W-1 **Wagner Electric Manufacturing Company** 1
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W-2 **Western Electric Co** 13
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W-4 **Westinghouse Electric & Manufacturing Co** 4-5-6
50-52 East Broadway, Butte; Van Nuys Bldg., Los Angeles; Couch Bldg., Portland; 212 So. W. Temple, Salt Lake City; First National Bank Bldg., San Francisco; Second and Cherry Sts., Seattle; Paulsen Bldg., Spokane.

W-6 **Westinghouse Lamp Co** .....
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W-8 **Western Pipe & Steel Co** .....
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